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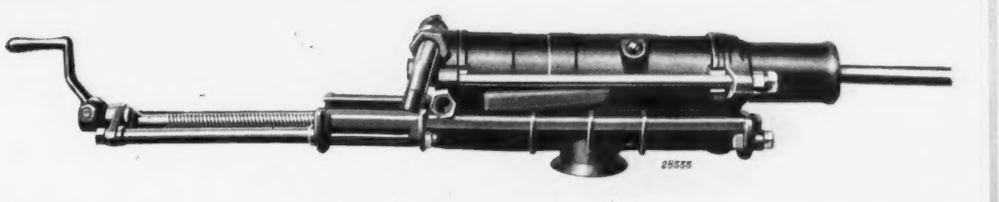

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Details of Ingersoll Rand's new High-Speed Drifters-

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N-75
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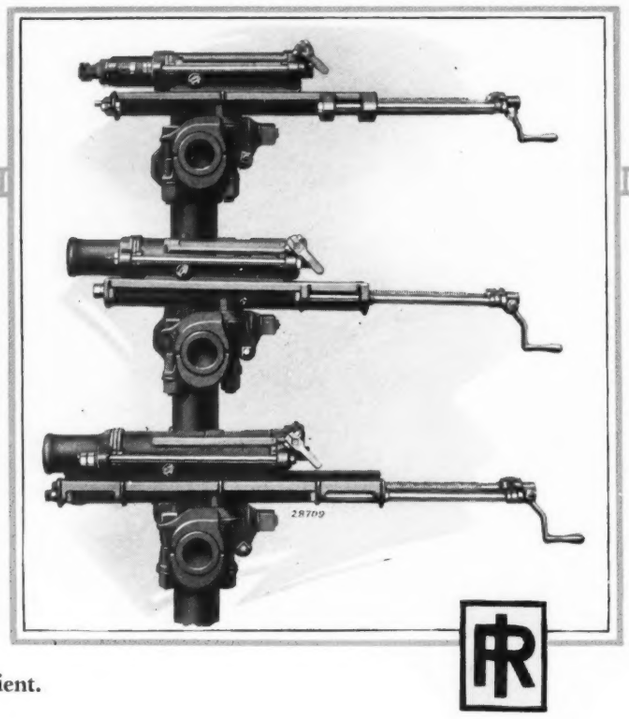

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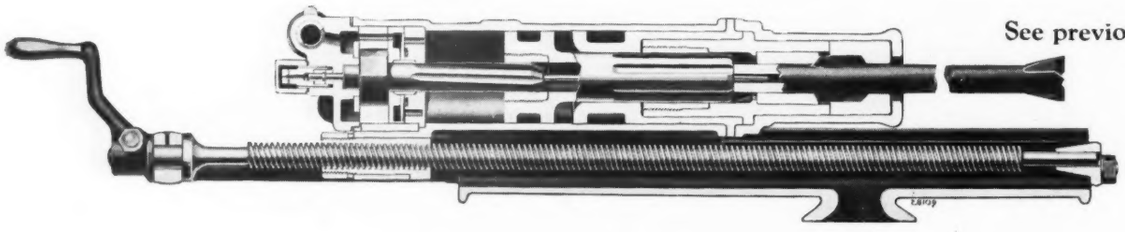
Height Overall	8-3/8″	Height Overall	8-9/16″	Height Overall	9-3/16″



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JAMES H. MCGRAW, *President*

A. W. ALLEN, *Editor*

VOLUME 125 — *New York, June 2, 1928* — NUMBER 22

The Air Mail Completes a Decade of Service

"NEITHER snow, nor rain, nor heat, nor gloom of night stays these couriers from the swift completion of their appointed rounds." Carved on the façade of the New York Post Office long before the institution of the United States air-mail program, these words were prophetic of the heroic flyers, typified by Lindbergh, who were to come. The service was established on May 15, 1918, before the war had ended, planes and pilots of the War Department being borrowed for the purpose. It has expanded beyond the expectations of the public until today 22 routes, covering almost 10,000 linear miles, are in operation; and new ones are steadily being provided. Daily the pilots travel more than 22,000 miles through the air, carrying an amount of mail that seems small in comparison with the extensiveness of the service. To all industry and to the public at large the facilities thus afforded have been of incalculable value. So it was appropriate that Postmaster General New should set aside the week of May 14 as Air Mail Week to commemorate the tenth anniversary of the institution of air-mail transportation.

Stabilizing an Industry by Control of Output

PRODUCERS of raw products, agricultural or mineral, have always been confronted with price difficulties. It will be conceded that price should include not only cost of production but also a fair return in the form of profit or surplus. Production in excess of demand, in proportion as the excess is small or large, seriously affects prices; and, as a consequence, there is a tendency for income to gravitate close to, or at times below, production cost. Some producers, under such conditions in an industry, make a profit, but the less favored usually have to shut down. The need for production control is obvious at times.

Dr. George Otis Smith, in *Mining and Metallurgy,* quotes the Coal Commission in regard to the government's responsibility in restraining over-development of coal lands, which over-development involves needless investment and excessive cost of operation. He states that the commission recommended the amendment of the leasing law, so as to give the executive department full discretion in its approval of the opening of a new coal mine on the public domain, making that approval contingent on the showing that the new mine would serve the interests of the consuming public. A similar situation exists in the petroleum industry. The close association of producer and consumer is such that, as he states, falling commodity prices cannot be looked upon as an unmixed blessing except when and so far as the reduction in price represents actual reduction in cost by invention of machinery or process improvement. In conclusion, he maintains that "The exercise of some control over production need not be feared, nor should it be opposed simply because it is primarily in the interest of the producer. It can well be sought as a step toward the ultimate goal in human economics—the greatest good to the greatest number over the longest time."

One of the simplest methods of production control in the mineral industries is the reservation of unappropriated mineral lands for future requirements by granting discretionary power to executive officers charged with the administration of the leasing law. It is objected that an effort to control production in the mineral field would arouse similar activity in other industries.

Two notable examples of production control are to be found in mining. One is the diamond industry of South Africa and the other the potash industry of Germany. The former started with many individual holdings at Kimberley, subsequently consolidated into the De Beers Consolidated Mines. There are now four important producing companies; and, to insure stabilization, their product is sold through a syndicate, which, by production control and contracts, has maintained prices. However, the discovery and development of new deposits upset the arrangement. In the last De Beers report it is stated that the discovery of rich fields in Lichtenburg has materially affected the four big diamond-producing companies. The chairman said: "We cannot continue decreasing our output to meet the enormous finds of the alluvial diggers, who produce diamonds as rapidly as possible and throw them upon the market within a few days of their being unearthed, regardless of the effect on the whole industry and the diamond market in general. If the big mining companies adopted the same policy there would be such a fall in prices that very few diggers would be able to work."

The situation called for governmental assistance. An act was passed which gave the government power to limit the maximum quantity in value of any precious stones which, during any period defined in any proclamation or regulation, may be recovered from alluvial, or disposed of after being so recovered. The four companies reduced their sales to a total of £2,800,000 per annum, but the alluvial diggers increased their production 237 per cent. The action by the government followed.

In the German potash industry overproduction and keen competition, resulting from too rapid development, caused the larger companies in 1879 to enter an agreement to limit output and determine distribution zones. Independents caused trouble, and in 1888 the Potash Syndicate was formed, all sales being regulated by a central agency. The control persisted and received govern-

mental recognition and assistance. After the war the potash law of 1919 made membership in the syndicate compulsory and placed control in the hands of a potash board appointed by the government. The functions of this board included supervision of the industry, fixing of domestic prices, and regulation of production. Later, power was given to the board to shut down unprofitable mines, compensation being given for inactivity by means of a quota charge. This is an example of restricted production and the centralization of a large industry under governmental control.

The difficulty in controlling production arises from the fact that an industry cannot be made 100 per cent inclusive except by government assistance. A serious study of the methods and achievements of the German potash syndicate would be useful and informative. A modification of the leasing law is only one step in a problem which sooner or later must be solved. It is a step in the right direction, because restraint in the development of new coal and petroleum deposits will relieve the present situation. To carry production control beyond this point presents many obvious difficulties, and may not be possible of accomplishment.

Indexing World Literature on Economic Geology

A COMMITTEE headed by Mr. Waldemar Lindgren and consisting, besides him, of Messrs. E. de Golyer, G. F. Loughlin, W. C. Mendenhall, and R. A. F. Penrose, Jr., is making an appeal for co-operation in the establishment of an annotated bibliography of the literature of economic geology. The plan of action has been formulated by the Division of Geology and Geography of the National Research Council and approved by the Council itself, by the U. S. Geological Survey, the U. S. Bureau of Mines, the A.I.M.E., and the principal scientific societies interested. The Council will serve as treasurer and custodian of funds. The bibliography will be issued at the rate of two volumes per annum. It will cover articles on all metallic and non-metallic deposits, including petroleum and gas, hydrology, engineering geology, and soils, as related to geology.

A subscription fund of $18,000 to $24,000 is required, to provide for the necessary editorial work over a period of from five to seven years. Subscriptions to date have aggregated about $9,000, and so a more extensive co-operation is needed to secure the success of the venture. Several mining and oil companies have contributed generously, but the rank and file of the profession—those who should be vitally interested in the advance of economic geology—have not responded to the degree that might well have been expected.

The appeal being made maintains, with logic, that "No country is sufficient unto itself, and least of all in science. All geologists probably realize this; and those who employ geologists should likewise realize that the efficiency of their staff is largely dependent upon familiarity with the progress of science throughout the world. We cannot afford isolation or imperfect knowledge. The enterprise represents a new step forward in economic geology, and it is fitting that this continent with its almost unlimited resources should lead in it."

The committee is eager to note a lively response from the profession, which response no doubt will be forthcoming when the facts are more widely known. The promise of a subscription of any size will indicate the interest that it is desired to evoke, and this should be sent to the National Research Council, Division of Geology and Geography, 21st and B Streets, Washington, D. C. Payments will not be called for until the total amount deemed necessary has been subscribed.

Finding New Outlets for Copper, Lead, and Zinc

A RECENT sociological survey disclosed the discreditable fact that of small estates—those of $1,000 or less—an entirely unwarranted part is devoted to burial expenses. The poor are the greatest sufferers from the extortionate charges of the morticians—as undertakers now prefer to be called—who have developed a practice of weighting the funeral bill with from $200 to $400 for a casket the material for which has cost scarcely 10 per cent of the item as charged.

From earliest times those charged with the preservation of the bodies of the great have employed tombs of stone, and lead and copper caskets. Today the use of metal for this purpose is extensive, but the cost is so great that only the well-to-do can afford what is considered a "luxury." No reason is apparent why this should be so, except the one suggested above, that under the stress of grief and pride, a charge can be exacted that bears no reasonable relation to the cost of the materials and the services supplied.

Why should a casket of copper or of bronze cost $1,000, or $500, or even $250, for that matter? A metal coffin, of inherent beauty and artistic design, to endure for centuries, should be possible of production, under conditions of standardized and mass manufacture, for less than $50, at a profit large enough to satisfy every equitable and legitimate expense, except the undertaker's excessive charge, in which the cost of his services is customarily concealed.

Fabricators of copper and bronze might well investigate the possibilities offering, for no avenue of consumption is more permanent than that created by the need of sepulcher. More than a million persons die in the United States every year. The majority of those whose duty compels them to accept responsibility for the disposal of the remains would prefer a metallic casket if the cost were not above reason. Only the exorbitant exactions of monopolists prevent a wider use of the nonferrous metals in this connection.

A Cartel of Copper Consumers in Europe Appears Unlikely

WHETHER as a reflection of serious consideration of the question by important consumers of the metal, or merely by way of making "copy," European trade and financial papers recently have discussed the possibility of organizing a cartel for the buying of copper. If the American producers are organized, why not the European consumers, they argue. The weapons with which it is suggested the purchasers might fight are of an indirect character. They might extend their influence in the production sphere of the industry, either by acquiring interests in producing companies or by cultivating the friendship of

independent producers; they might promote dissention in the ranks of the members of the producing cartel. Another possible avenue of activity is stimulating the salvaging of old and scrap metal, and the fostering of the use of substitutes for copper, particularly aluminum. It is suggested that some group agency charged with advising consumers as to the opportune time to make their purchases or to defer buying might prove to be of advantage.

That any of these measures would be particularly helpful in reducing the price of copper to the foreign consumer is hard to see. Promoting the use of substitutes might tend to decrease consumption; but, if the producing cartel is functioning successfully, prices would not be lowered by a decrease in consumption: the tendency would be in the contrary direction. In view of the general business acumen and keen insight into economic and marketing problems possessed by most industrialists in Great Britain and the Continent, it seems doubtful if a copper-purchasing cartel will be formed.

Impropriety of Officials Benefiting by "Inside" Information

COMMENTING on the recent address of Judge Edwin B. Parker, of the Chamber of Commerce of the United States, last week we emphasized the fact that officials and directors of an incorporated company—whether engaged in mining or some other activity—have recognized obligations to their shareholders. One of the proud boasts of Judge Gary was that no director or committeeman of the United States Steel Corporation had ever taken advantage of advance information regarding plans or policies of the company, to benefit personally by stock-market operations. Without expressing any opinion as to whether or not Mr. Gary was too trustingly trustful, one may venture—without undue cynicism—the opinion that most mining company officials and directors, personally or through their relatives and friends, take advantage of reports of good or bad developments that come to their attention in the regular course of business. They feel that this is a perfectly proper procedure, and that the privilege is a perquisite of their office. The point is a nice one; but custom has apparently stamped the practice with approval. A distinction, however, may be drawn between making use of the early possession of information, and deliberately misleading shareholders, either directly or indirectly, into assuming the existence of a position that the officials know to be contrary to fact.

The following incident came to light at the recent annual meeting of the Cliff Mining Company, controlled and operated by the Calumet & Hecla Consolidated Copper Company: The chairman and the president of Calumet & Hecla, who are, respectively, president and vice-president of Cliff, early in 1926 allowed the report to be published and circulated without contradiction that certain exploratory operations then in progress at the Cliff property were to be "permanently abandoned." This, it is alleged, gave the impression to Cliff shareholders that the property was considered to be of little potential value. At the same time, however, the officials mentioned had in hand a new and favorable geological report on the Cliff that they did not make public; and they knew that before many months, in all probability, another program of exploration would be started on the Cliff ground. It was disclosed at the meeting that, contemporaneously with the publication of the unfavorable news story, the vice-president of Cliff purchased 4,000 shares for himself and 2,000 shares for his friends; and the president of Cliff purchased for himself 4,800 shares. Prices ranged from $3 to $5 during the period. That they were not mistaken in their belief that the shares were a good buy is indicated by the fact that the new work was started, and that the shares later in the year went up to $12.50. Two stockholders of the Cliff company at the recent meeting are reported to have declared that the president of their company, when questioned on the point about a year ago, "vehemently denied" that he had purchased any stock of the corporation since the shutdown.

The reason given by the officials for withholding the report recommending the new work subsequently undertaken is that publicity would have interfered with negotiations of Calumet & Hecla looking to the acquisition of certain mining lands and a short railroad. Considerably higher prices than those actually paid would, say the officials, have been exacted had the plans recommended in the report been made public. As officials of Calumet & Hecla they doubtless were justified in suppressing information in order to drive a good bargain. Whether they were morally justified as officials of the Cliff company in withholding from shareholders information having an important bearing on the value of these shares, and then proceeding to buy from the shareholders for their own account, is a problem in ethics that is open to debate.

Utilizing the Toxic Properties of Colloidal Lead

THE earliest use of lead was probably in warfare. As civilization progressed and its uses became diversified, the toxic properties of the metal and its compounds were realized. From the time of the operation of the early lead metallurgical plants, and the accepted use of white lead in the paint industry, lead poisoning has been a menace. On the other hand, research work is under way in an effort to utilize the toxic properties of this element, in extending the span of human life and lessening suffering from disease.

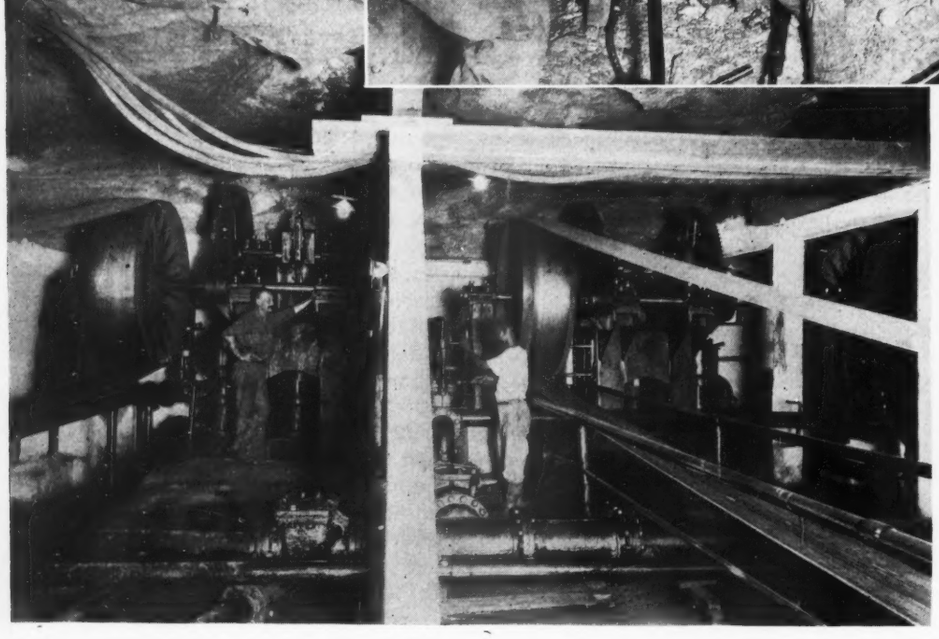
The use of lead in colloid form, in the local treatment of cancerous growths, is being thoroughly investigated. Apparently there is a possibility that it will supplant radium for this purpose. Success is not assured, though preliminary results are favorable, and a comprehensive study is under way.

Speaking before a recent meeting of the Chemical Section of the National Safety Council, Dr. Frederick L. Hoffman, of the Babson Institute, stated that of about 600 victims of lead poisoning coming under his surveillance none was afflicted with even a benign tumor or nonmalignant form of cancerous growth. This fact is remarkable, considering the normal proportion of persons who are so afflicted. Reasoning of this nature is not conclusive, but it is indicative. The value of one poison in combating the influence of another poison in the human system is recognized by medical science. An efficacious treatment for cancer is urgently needed, and the experiments with colloidal lead will be watched with considerable interest.

Mine Mechanization in Africa

Battery type locomotive (General Electric) hauling ore in the Randfontein Estates Gold mine, in the West Rand.

Consolidated Pneumatic (No. 5) rock drills at work in the bottom of the Flora shaft of the West Rand Consolidated Mines.



Underground station of Goulds pumps at the Modderfontein Deep Levels mine.

Generating Power for the Rand

Witbank Station, Near Johannesburg, One of the World's Most Economical Steam-Electric Plants—The 132,000-Volt Transmission Is Over Aluminum Cables

By JOHN WATSON
Johannesburg, Transvaal

WITBANK, 89 miles by rail from Johannesburg, boasts a power station consisting of three main generating sets of 20,000 kw. each, and twelve boilers, each of a normal capacity of 70,000 lb. of steam per hour. The plant was put in commercial operation on July 1, 1927. Owing to the increased power requirements of the Victoria Falls Company on the Rand, and of consumers in the Witbank area, the capacity of the Witbank station will be augmented by the installation of a fourth 20,000-kw. generating set and three additional boilers, thus bringing the installed capacity to 80,000 kw. A beginning was made with the excavation and foundation work early this year, and it is expected that the addition will be completed toward the end of 1928.

Witbank station is owned by the Electricity Supply Commission, but was erected and is operated by the Victoria Falls & Transvaal Power Company. Designs for the station were prepared by the power company's engineering staff in collaboration with Merz & McLellan, of London, consulting engineers to the commission. The commission has the right to take over the operation of the station while supplying the Power company with all the surplus energy the station can produce, and which it is estimated will amount to between 300 and 400 million units per annum. The commission also has a license to supply consumers within a 15-mile radius of the Witbank station. These, however, take only a negligible proportion of the output, the remainder going over the Power company's 132,000-volt transmission lines to a step-down substation, where it is distributed through the company's network along the Reef.

A rumor reached New York that power was being supplied to the Rand mines at a cost of 0.06d. per unit, but this is not a fact. The figure was probably suggested by the tariff of the commission for supply within the 15-mile radius, which is £6 per kilovolt-ampere per year, plus 0.06d. per unit. The tariff of the company to mining consumers on the Rand averages about 0.45d. per unit, other industrial consumers being supplied on a separate tariff, at a somewhat higher average rate. Under the terms of the contract, consumers participate in surplus profits, after certain charges are made, which reduces the above-mentioned price.

Generating costs at the Witbank station are probably among the lowest in the world, owing to the fact that a contract was negotiated with several colleries associated with the Transvaal Coal Owners' Association for the supply of Duff coal for a period of twenty years at a price of 1s. 9d. per ton, free on truck at pit's mouth. At present the pits are so situated, relative to the generating station, that the coal is hauled in trucks belonging to the Electricity Supply Commission, by its own locomotives over private sidings, so that the delivered cost is only slightly higher than the pit-mouth price. The calorific value of the coal is about 11,400 B.t.u. per pound as received, and the coal is graded through a $\frac{1}{8}$-in. screen. The contract provides for a supply up to 40,000 tons a month at the above-named price, any additional tonnage costing 2s. 6d. per ton, free on truck at the pit's mouth. When the Witbank station is in full commercial service, the coal consumption will be 40,000 tons per year.

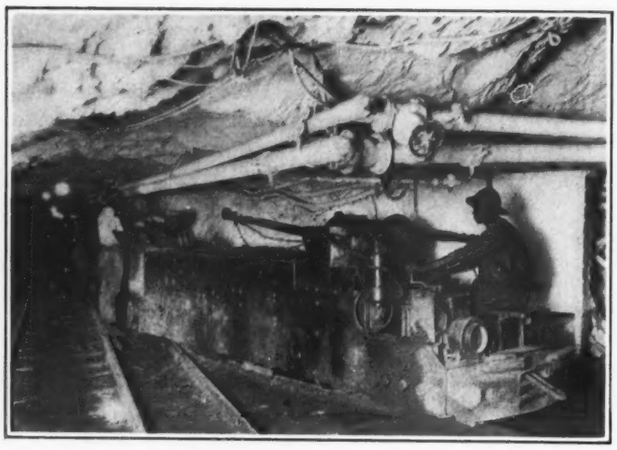
Within eleven months of the time of arrival of the first building material on the site the first 20,000-kw. machine was running, such was the rapidity of construction, which was a credit to all concerned. The plant has been reliable and efficient, the working costs making, in all probability, a world's record for steam-generated power. Two principal factors contributing to this result are, first, that the station can dispose of its whole output to the enormous power-supply system operated by the Victoria Falls & Transvaal Power Company; and, second, to the fact that the station is in the heart of the Witbank coal field.

Compressed air is also sold by the Power company. One of its uses is in this Ingersoll-Rand "Little Tugger," here used as a slusher or scraper on Level 46, south crosscut of the Robinson Deep Gold Mines.

The station is run at a high load factor. Output of the three generators in 1927 was 438.7 million units.

Total sales of the Power company for 1927 were 1,128 millions. Of this total, 180 millions was in the form of compressed air, which is sold on the kilowatt energy basis and is conveyed through a network of pipe lines.

The turbo-generators, supplied by C. A. Parsons & Company, Newcastle-on-Tyne, run at 3,000 r.p.m. and are supplied with steam at 240-lb. gage and a temperature



Cheap power facilitates underground tramming. A Goodman trolley-type locomotive in a mine on the West Rand.

of 340 to 350 deg. C. Each turbine requires 1,200,000 gal. of circulating water per hour, which is passed through sprays to effect the necessary cooling. The make-up water is pumped from the Davenpoort Dam, on the Olifants River. Switchboards and transformers at the generating station end and also at the step-down substation, at the Brakpan end of the main transmission line, were supplied by the Metropolitan Vickers Electrical Company. The Witbank-Brakpan 132,000-volt aluminum transmission line, with steel core, is the property of the Power company. This line, so far, has fulfilled all expectations as regards reliability and efficiency.

The cost of the Witbank station to date has been about £1,250,000.

In conclusion, the writer here extends his thanks to Mr. Van Dalsen, of the Electricity Supply Commission, and to Mr. Bernard Price, general manager and chief engineer of the Victoria Falls & Transvaal Power Company, for information embodied in this article.

Domestic Asbestos Production Only 1 per Cent of Imports

THE total quantity of asbestos sold or used by producers in the United States in 1927 was 2,986 tons, valued at $338,066, according to figures compiled by the U. S. Bureau of Mines. These figures represent chrysotile asbestos mined in Arizona, and amphibole asbestos mined in Georgia and Maryland. Sales of chrysotile asbestos were much larger, both in quantity and value, than those of 1926, and the sales of amphibole asbestos showed an increase in quantity but a decrease in value. Imports of unmanufactured asbestos for consumption amounted in 1927 to 223,693 tons, valued at $8,150,340, and the exports were 309 tons, valued at $48,774. Corresponding figures for 1926 were: imports, 257,621 tons, valued at $8,142,505; exports, 1,104 tons, valued at $85,922.

Rock Drills for Boring Deep Holes

WORK in Spain in prospecting the walls of drifts and crosscuts with deep-boring compressed-air rock drills, is described by Charles Stewart in a recent bulletin of *The Institution of Mining and Metallurgy*. The drill used was a Waugh 34 independent-rotation "Turbro," manufactured by the Denver Rock Drill Manufacturing Company. Rocks encountered comprised porphyry, highly siliceous and hard, containing veinlets of chalcopyrite or other copper and iron sulphides in the form of a stockwork. The threads of the rods are forged by a drill sharpener on 1¼-in. steel. After forging, the ends of the rods are trued and hardened by the same treatment as is given to drill shanks. No shoulder is formed, the rods making a butt joint in the sleeve.

A little trouble was experienced with the breaking of the 3-ft. rods and shanks at the thread in starting the hole, but this has been much reduced by the more careful manipulation of the machine by the drill runner.

In drilling holes slightly above the horizontal up to 70 ft., water under 70-lb. pressure will eject the cuttings satisfactorily; but when drilling deeper holes higher pressures must be used, according to Mr. Stewart. The swivel coupling works easily and does not seem to retard the rotation of the machine. Care must be exercised in coupling the rods so as to insure the rods meeting end to end. The threads should be well greased. This prevents leakage of the water and facilitates the uncoupling of the rods; usually, after a few taps on the sleeve with a small hammer, the rods can be unscrewed by hand.

When drilling in hard formations, it is necessary to take great care with the gage, the Spanish operators discovered. Provided the wear is not greater than $\frac{1}{16}$ in., no difficulty is experienced in following with a bit of the same gage. By reducing the third bit $\frac{1}{32}$ in. it is possible to advance a few feet before starting the next series. In softer formations, such as slate, the hole can be started with a smaller bit and no alteration of gage will be required. The following describes the drills used in one campaign:

No. of steels	27
No. of sets	9
No. of steels in set	3
Bit gages	3½, 3¼, 3, 2¾, 2½, 2¼, 2⅛, 2, 1⅞
Type of bit	Cross bit
Length of rods	6 ft. and 3 ft.
Rod coupling	Muff type

To obtain large footage it is obvious that each bit, especially in the larger sizes, must be worked to its utmost capacity. If the driller is not careful and drills too deeply before changing to the other similar-sized bit of the same set, he is likely to lose the maximum depth of hole by dropping his gage too quickly.

The following table gives the actual works' cost of drilling three holes:

No. holes				3
Total depth	326 ft. (in holes of 110 ft., 98 ft. and 118 ft. respectively)			
	£	s	d	U. S. Currency
Drill sharpening		17	0	
Compressed air	3	2	0	
Oil grease and waste	1	16	0	
Repairs to rods		14	7	
New shank	2	1	5	
Wages	12	10	0	
Total	£21	1	0	$102.50
Or, say, 1s, 4d ($0.34) per linear ft.				
Drilling shifts (8 hour)				18
Recovery of broken rods				2
Footage per drilling shift				18.11 ft.
Footage per shift worked				16.3 ft.
No. of bits broken				1
No. of rods broken				3 of 6 ft. 3 of 3 ft.
Sleeves cracked				1
Shanks broken				1
Labor				1 drill runner 1 helper 1 tool boy

Dust Control in Southwestern Ore-Milling Plants

Initial Equipment Cost of a Few Thousand Dollars Is Returned in Two or Three Years

By GEORGE E. LYNCH
Consulting Mechanical Engineer, 414 Hollingsworth Building, Los Angeles

A RECENT EDITORIAL in *Engineering and Mining Journal* sets forth clearly the evils due to dust in dry milling, and strongly condemns the attitude of indifference to such hazards shown by many companies. Every engineer engaged in dry milling knows that the conditions described are not overdrawn. Dust elimination, except in a few sections, is generally regarded as a super-refinement. A conspicuous exception to this indifference is afforded by the attitude of the larger copper companies of the Southwest. Dust-collection units have been installed in nearly every large plant there, and, with the completion of the plant for the Nevada Consolidated Copper Company, in its mill at Hurley, N. M., the field will be covered 100 per cent.

The Phelps Dodge Corporation, as usual, was the pioneer in this work, and all its plants have been so equipped. A dust-collection unit was installed in the Morenci plant many years ago, designed by company engineers. In spite of the scarcity of data then available, it is remarkably close to the type developed by later experience. This plant was slightly remodeled and brought up to date about two years ago. The original plant used two No. 70 American Blower exhausters. On remodeling, it was not considered advisable to replace these fans with larger ones, so the amount of air available is a little scant; but the plant is clean, and conditions are healthful. The first method of collection was entirely wet, but unloaders were provided later, so that part of the dust is returned dry to the mill flow, thus relieving the wet collectors to some extent.

The first plant to use modern dust control was that of the Moctezuma Copper Company, belonging to the Phelps Dodge Corporation. This was designed early in 1923 and completed in June of that year. The dust system is in the crushing plant only. Daily crushing capacity is 3,000 tons, reduction being effected by two No. 9 gyratories, two Telsmith crushers, and two 48-in. vertical Symons disk crushers, with screening by ring-type grizzlies between stages. A 60-in. American Blower exhauster is used, requiring about 14 hp. Total collection is about 13 tons of dust daily, of which 8 tons is returned dry to the fine-ore belt and 5 tons is thrown down in the spray tank, flowing by gravity to the flotation plant. An interesting feature is that the fine dust carries nearly twice as much copper as is contained in the heads, so that the direct saving in salvaged metal is very high. The total cost of this plant was about $6,000.

The next important plant was at the new Copper Queen mill at Warren, Ariz. It was designed before completion of the Moctezuma plant and was put in operation on Aug. 1, 1923. The mill handles 4,000 tons of ore per shift, or about 500 tons per hour when running at capacity. This ore is a steam-shovel product—2½-yd. dippers—and is reduced dry to 1¼ in. Crushing is done by one 66x84-in. jaw crusher, two No. 9 gyratories, and four 48-in. horizontal Symons disk crushers. Screening between stages is performed by ring-type grizzlies and stationary grizzlies. On account of the design of this mill it was necessary to use a double-unit system and to keep the main headers on the outside of the building, out of the way of the cranes. Two 80-in. Sturtevant mill-type exhausters are used, each taking 22 hp. Collection is about 22 tons daily dry, and four or five tons of wet dust. Dry collection is done ahead of the fans, the extremely fine dust passing the collectors having apparently no bad effect on the runners during five years or so of operation. The total cost of this plant was about $12,500. Daily operation cost is estimated at about $4, or 0.1c. per ton of ore milled.

The Ray plant of the Nevada Consolidated Copper Company was designed next. This mill handles about 6,000 tons daily from run-of-mine to ¾-in., crushing being done by two large gyratories and two sets of rolls, with Hum-mer screens ahead of the primary crushers and also in closed circuit with the rolls. One 80-in. American Blower exhauster was installed here, using about 24 hp. Dry collection is ahead of the fan; and it was planned to drop in a spray tank the fine dust passing the collector. Unfortunately, at the time of installation, water was extremely scarce, only five gallons per minute being available for sprays. This disadvantage was overcome by directing the final discharge downward into an old tunnel below the mill, where it was diffused and settled without causing nuisance. The wet dust showed only very small amounts of copper, so that it was not worth while to dewater and save it. This plant cost about $6,000 complete. No data are available as to the amount of dust collected daily, but I would estimate it at approximately 14 tons.

About this time, the New Cornelia plant at Ajo, Ariz., was completed. The dust system here was designed as part of the mill. It uses four 45-in. exhausters, which discharge into dry collectors, the final air being then passed to wet cyclones. Cleaning is satisfactory. The

use of fans ahead of the dry collectors causes wear of the runners, so replacements are occasionally required.

A large dust-collecting unit was installed at the Clarkdale plant of United Verde Copper about the end of 1923. This used two No. 9 conoidal-type Buffalo exhausters, each handling about 45,000 cu.ft. of air per minute, and requiring about 95 hp. each. Collection was entirely dry, by means of a Cottrell electrical precipitator ahead of the fans. The coarse-crushing department contains four 36x48-in. Blake-type jaw crushers; the screening building, the banks of Hum-mer screens; and the fine-crushing section, three 48-in. Symons vertical disks and three sets of 54-in. rolls with Hum-mer screens in closed circuit. The Cottrell precipitator and the fans were housed in a separate building near the center of the group; and the collected dust, amounting to about 27 tons per day, was discharged into small cars and hauled to the smelter at intervals.

OPERATION of this plant was not satisfactory, and it was redesigned in the summer of 1924, to approach more nearly to the methods used in other mills. Pipe locations were changed to avoid filling and clogging; and unloaders were installed to clear the system and to reduce the load on the Cottrell. By these changes, about 85 per cent of the dust was dropped in the unloaders, leaving only about two tons per day to be caught in the precipitator. The total amount collected was also somewhat less with the new arrangement, inasmuch as the object of the system is to clear the mill and not to collect dust.

Both fans were slowed down from 825 r.p.m., the original speed, to about 500 r.p.m. On test, it was found that one fan at this speed developed ample suction for the system, so the other was held in reserve. The Cottrell showed a high efficiency of collection by weight of material, nearly 97 per cent of the contained solids being caught and eliminated. The remaining 3 per cent made a showing in the discharge entirely out of proportion to its weight, however, and serious complaints came from the smelter and the power house, whither this fine dust was carried by the wind. For this reason, and also to avoid the cost of the skilled attendant on the Cottrell, I recommended its replacement by two 14-ft. spray tanks, the installation of a new flotation plant making it possible to utilize the wet pulp thus obtained. The design was prepared for construction at the company shop, and installation when convenient by company men. Up to the time of writing, these tanks had not been installed.

The effect in the mill is good, but much better and less expensive results might have been secured by building three separate small dust systems. In general, redesign of old systems is exceedingly difficult unless the entire installation is torn out and replaced, which is costly.

A DUST-COLLECTION unit was installed at the plant of Allenby Copper (a branch of the Granby Consolidated M. & S. Company, in British Columbia) in 1926. This plant handles 2,500 tons per day of ore already broken to about 3 in. Two sets of 72-in. rolls in series and in circuit with screens deliver $\frac{3}{4}$-in. rock to two 54-in. rolls in parallel, also in circuit with Hum-mer screens, the final product being reduced to $\frac{3}{8}$-in. An 80-in. Canadian-American Blower fan is used, requiring 28 hp. About 85 per cent of the dust is unloaded dry ahead of the fan, and the remainder is wetted in a wooden spray tank, after passing through the fan. The wooden tank was adopted to prevent freezing of water on the inside of the shell; the wood staves form a fair insulation against the low temperatures sometimes reached there, and the warmth of the incoming air is sufficient, thus protected, to avoid ice formation in the tank. This plant cost about $6,500 and was erected by a sheet-metal contractor.

Conditions were especially difficult, the entire milling plant being built of wood. The chutes and elevator legs were thus likely to develop leaks and spills, difficult to locate, but each contributing its quota of dust to the air. However, after the main sources of dust were checked, it was easy to find small leaks; the carpenter could close them at his convenience, because each showed itself by a pyramid of fines on the nearest floor surface. Tests proved that the fine collected dust returned from the spray tank had no apparent colloidal action in the flotation cells, and that its contents of value floated as readily as did those in the tube-mill product.

Several dust-collection plants were installed in 1927, the most important being that at the Miami Copper Company at Miami, Ariz. This mill handles about 14,000 tons of ore per day, reduction being by two Telsmiths and one Newhouse suspended-type crusher. The product from these, after passing the battery of Mitchell screens, goes to two sets of 72-in. rolls in tandem and in circuit with the screens, there being four pair of rolls in the system. Here, as at the Copper Queen plant, it was necessary to run the piping outside the mill to avoid the cranes; but, unlike that plant, the design did not lend itself to a double-unit system, and a single 42-in. header was used, leading to a 14-ft. spray tank at the lowest point of the system. A 100-in. Buffalo slow-speed exhauster is used, placed outside the spray tank and requiring about 28 hp. for 42,000 cu.ft. of air per minute.

COLLECTION is about 6 tons of dry dust and 21 tons of wet dust per day, the high proportion of wet dust being attributable to the fact that there was no opportunity to install unloaders in the line below the primary roll floor, so that all the dust below that point went to the spray tank. The first provision of sprays allowed a supply of about 20 gal. per minute. This was ample to drop the dust, but it did not dilute the pulp sufficiently to allow it to flow from the tank, and it was necessary to increase the water to about 60 gal. per minute to prevent the building up of mud and the clogging of the tank. The present flow is about 60 gal. per minute at 6 per cent solids, which appears to be the highest solid content that can safely be depended upon to flow cleanly and keep the tank free. The cost of this plant was about $9,500. It was erected by company men while the mill was in full operation, without, apparently, causing delay. The wet dust is pumped back up the hill to the flotation mill, the crushing plant at Miami being at the lower end of the system.

Two smaller dust systems were installed at the new lead mills of the Phelps Dodge Corporation at Warren and at the Douglas smelter. The system at Warren uses a 70-in. Sturtevant exhauster on the outside of a 6-ft. spray tank, all dust being collected wet. The pulp flows by gravity direct to the intake of the Dorr classifier in the mill. In the sample plant it was necessary to keep all pipe connections on the reject chutes, so as to avoid possibility of salting or impoverishing the sample. The incoming ore is crushed in a Blake-type crusher, thence passing to a 4-ft. Symons cone crusher. From here it passes to the sampling plant, where the sample is taken and reduced by small rolls.

The sampling plant at Douglas uses a 50-in. direct-driven American Blower exhauster, handling about 10,000 cu.ft. of air per minute. Connections are made on the reject chutes here as at Warren, inasmuch as custom ore is handled and great care must be used on the sample, some of the ores being high-grade. The fine dust usually assays the same as the ore, and must be saved; it is imperatively necessary to keep it out of the mill. However, as it was to be fed directly to the sintering machine, it could not be wet, as at Warren. Dewatering was out of the question. The problem was solved by using a form of air filter, which seems to accomplish the purpose very well, collecting almost all the fines. The filter medium is a bed of crushed slag, which is circulated at intervals, dropping its adhering dust and returning to the bed. This is covered by patent application.

A dust-collection plant was installed by the Inspiration Copper Company at Inspiration, Ariz., in 1927, design and construction being by an Eastern company. This appears to clean the air well, but difficulty is experienced in dropping the collected dust, which blows back into the mill. This may have been corrected since my visit there; the remedy is simple.

A dust-collection system was designed for the Old Dominion Copper Company at Globe, Ariz., but its installation has been delayed because of changes in the mill. Erection will be made after the enlarged mill is in operation and dust sources have been identified.

The most recent large plant to be designed is that at the Hurley mill of the Nevada Consolidated Copper Company at Hurley, N. M. This is about the same capacity as the one at Miami, except that elevators are used for the handling of ore instead of long, incline conveyors. This feature insures a compact plant but complicates the placing of the dust piping.

CRUSHING is by two No. 9 gyratories and one 7-ft. Symons cone crusher. The product from these goes to three sets of 72-in. rolls in parallel and in closed circuit with Hum-mer screens. The construction of the plant makes it necessary to keep all piping, except three vertical risers to the elevators and the screens, below the roll floor. Piping is arranged in two groups, each unloading on one of the fine-ore conveyors and both delivering into one spray tank outside the building. A No. 9 Multivane Sturtevant exhauster is on the outside of the spray tank and will use about 24 hp., delivering about 33,000 cu.ft. of air per minute. The wet dust will flow by gravity to the flotation plant. Use of a multivane fan is new, but it was found at Miami that the dust passing the spray tank is so small in quantity that it will not cause any difficulty with the small blades, and the low price and high efficiency of the Multivane commend its use. This plant is probably now completed. The estimated cost is about $9,000 complete. It is probable that the total collection of dust will be about the same as at the Miami plant, but the proportion of wet dust will be much smaller, as both lines are unloaded just ahead of the spray tank.

The above résumé indicates some of the activities in dust control in the last few years. Most of the information is from first-hand sources, as I have worked on all the properties mentioned except Inspiration and New Cornelia. Many smaller plants have been installed and some large plants in other industries. Data given herewith cover only the field of copper-ore milling, with one or two exceptions. Descriptions indicate that nearly every type of crushing equipment was used. The cost shows that none of these plants could be regarded as extremely expensive, considering the large capacity of the mills and the amounts of dust to be controlled.

Primarily, all of the plants were installed with the single aim of improving working conditions for the men. This was done without legal or other pressure, but simply as good business. A surprising and gratifying feature of all these plants, however, is the fact that every one pays a substantial direct profit on the investment in salvaged copper, formerly lost in the dust. This is easily measured in dollars and cents. The indirect profits, although difficult to estimate, are conceded to be much greater than the direct. Decreased wear of bearings and gears and avoidance of delays for repairs and replacements are important items, as are also the reduction of short circuits owing to dust in windings of motors, and the saving of cost for blowing out this dust each shift. The expense for sweeping the mill and cleaning the machinery is greatly lessened, with the accompanying advantage that any spill or leak shows up at once and is quickly remedied.

THE most important of the profits is the increased morale and efficiency of men working in a clean mill, and the reduced labor turnover induced thereby. In my frequent visits to the mills which have been cleaned in the last five years, I observe little change in the personnel. The same gang is on the job, from foremen to laborers. In general, old employees are safe men. They have learned the special dangers of that mill and know how to avoid accidents and how to get results in the quickest way. Any new man, however intelligent, is a liability until he knows the ropes, and his education costs money that can be spent to better advantage elsewhere.

As it has thus been proved, in one large industry, that dust control is good business, it is hard to understand the reluctance of many companies to introduce it in their plants. A new machine or process that will return 33⅓ per cent on its cost in one year should not require much salesmanship for its introduction. In many years' work with dust, I can recall no single installation that has not shown a much larger return. Indeed, most of those installed of late years show direct annual profits in excess of 50 per cent on the investment, with no accounting of the indirect savings whatever. I can conceive of no condition, in which any dust system whatever is justified, where the total cost of the installation would not be returned in less than three years after allowing for the cost of operation.

IT MUST not be understood from this article that the cleaning of the mills described was, in any way, a half-way operation. As a mill foreman expressed it, using language that may be familiar to some readers, "Catching dust is like drawing to a straight—80 per cent don't get you nowhere."

The usual test for dust-free conditions is to observe a slanting beam of sunlight against a dark part of the mill. If any dust shows in the beam, the job is not finished. Needless to say, this is a sensitive test, but the fact that such cleanness is obtained and is kept up by the efforts of the men themselves, shows that maintaining a healthy atmosphere in a mill is not a difficult or complicated task. The editor is entirely justified in condemning those who maintain dusty mills and in prophesying that these conditions will soon be impossible in any industry.

area of uniform conductivity the strike reading at each observation station should coincide with the strike of the survey line—that is, the receiving loop should always point to the sending loop, whereas the dip readings should be everywhere zero—and the receiving loop should be in horizontal position. This rule applies only to an area without major topographical changes; this not being the condition, a correction value must be applied to the actual readings to eliminate these influences of the topography.

Corrected readings plotted in Fig. 1 show considerable deviations from these normal values. Supposing the observer to be standing at the sending loop—which is indicated in Fig. 1 by a small vertical line at the left-hand side—and looking up the survey line, a strike deviation to his left is shown by positive values in the curve, one to the right by negative; a dip deviation toward him by positive and one away from him by negative values.

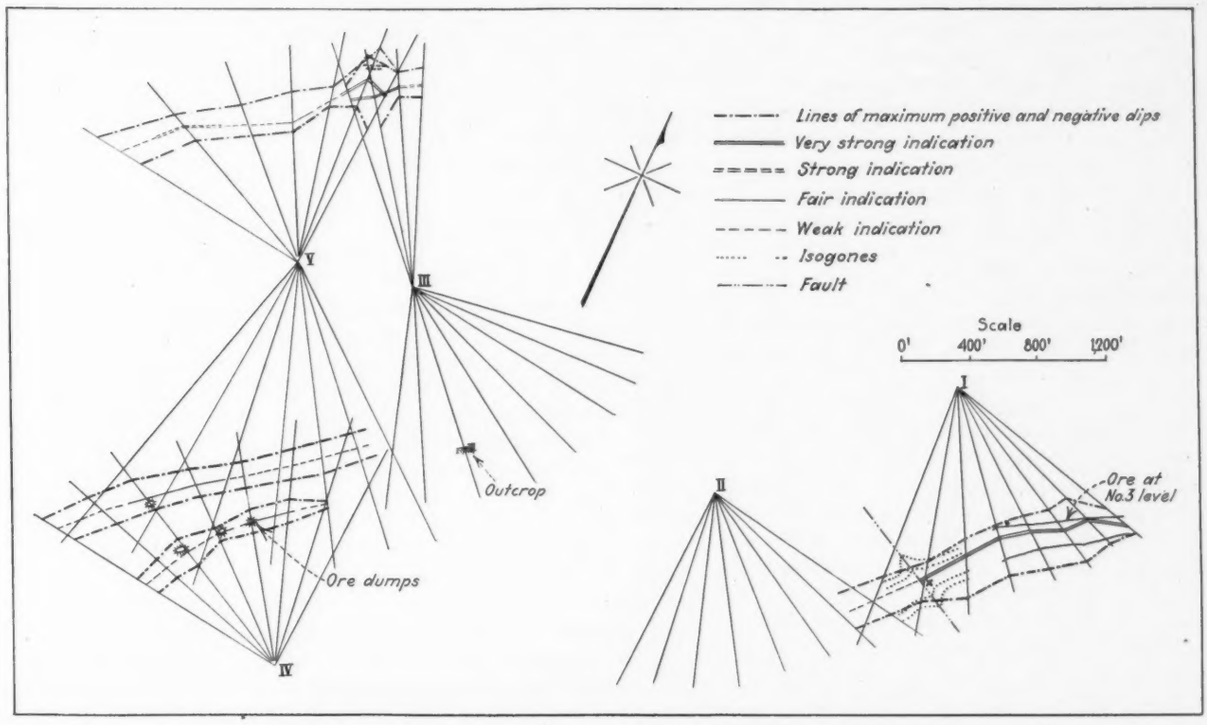


Fig. 3—Map, in plan view, on which observations were plotted ——

Strike and Dip Curves Afford Valuable Data

Studying the strike curve, it will be observed that it shows a strong strike deviation to the right, the maximum value of 18 deg. being found vertically above the point where the dip curve passes through the zero line. This means that in the vicinity of the station where this maximum value was determined the induced current in the ground has deviated 18 deg. to the right through the influence of a good conductor.

The dip curve, however, yields much more information. According to theory a good conductor standing vertically in the ground causes deflections of the dip angles as shown in Fig. 2. The point O where the dip changes from positive to negative values coincides with the axis of the good conductor, whereas the points A and B represent the maximum positive and maximum negative dips, their distances from O being equal ($a = b$). At the same time c is equal to d; that is, the maximum positive value is equal to the maximum negative value. It will be further noted that the projection of the conductor lies between the points A and B, although a plus b is usually greater than the width of the conductor. A dip of the conductor to the left would cause O to move to the left ($a < b$), and to decrease c ($c < d$), whereas a dip to the right would have the opposite effect. The combined value of c and d is at the same time a measure for the strength of the indication, which in turn is dependent on the degree of conductivity of the conductor and its depth below the surface. The degree of conductivity is chiefly determined by the strength of the

The sending loop

An Electromagnetic Survey in the *Ducktown District*

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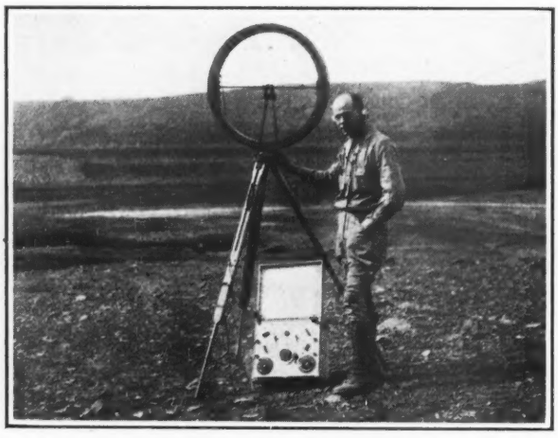
GENERAL PRINCIPLES of geo-electric investigations have been set forth a number of times in the technical press, so it is permissible to omit explanation of them in this paper. Our purpose is to describe in the following the results achieved by an electromagnetic survey in the Ducktown Basin, with the object of showing what results can be expected from such a survey under geological conditions similar to those existing in this district.

The country rock in the basin is of Cambrian age and consists of a series of highly compressed, metamorphosed and schistose sedimentaries, in the main, shale, graywacke, and conglomerate. A number of basic dikes are



The receiving apparatus

intruded in the sedimentaries. Ore deposits occur as roughly tabular bodies in veins, the strike of the latter being parallel to that of the schists. The dip is predominently at steep angles to the southeast. Local folding and faulting, however, have frequently resulted in reversing the dip, flattening it and increasing the width of the oreshoots. The ore consists of massive pyrrhotite, pyrite, and chalcopyrite, grading along the strike and dip into a lime-silicate gangue. Oxidation has taken place to moderate depths, seldom reaching more than 100 ft. below the present surface. The outcrop of the veins at some places is marked by a strong showing of gossan. At others, however, it is very indistinct, probably owing to collapse during oxidation and subsequent concealment by débris from the adjacent country rock.

The equipment used for the electromagnetic survey may be described briefly as follows: The power output of a portable gasoline engine was transformed into alternating current of 1,000 cycles frequency by means of a low-frequency oscillator. This current was sent through a sending loop, suspended vertically and easily

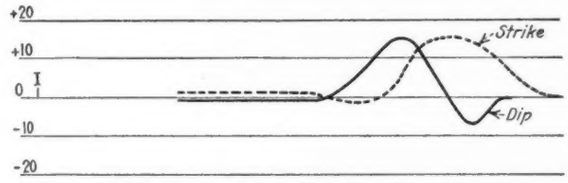


Fig. 1—Strike and dip curves

rotatable around its vertical axis, thus creating a secondary electric field in the ground. The latter was investigated by means of the receiving apparatus, consisting of a small circular loop mounted in such a manner that it was rotatable around a horizontal and a vertical axis. This receiving loop was connected in series with a telephone and a tuning and amplification device to insure the highest degree of sensitivity.

Referring to the map (Fig. 3), a series of lines will be found radiating from several points numbered in the roman fashion from I to V. At these points the sending loop was placed and readings with the receiving apparatus were taken along the survey lines at a number of equidistant stations; that is, two readings at each observation station, one to determine the azimuth position or

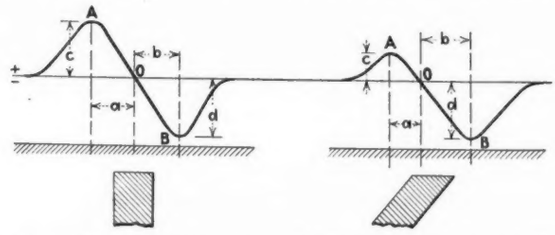


Fig. 2—Dip curves for two different ore dips

strike of the loop at which there is a minimum response —the maximum response being at right angles to the latter—and the second to determine another minimum response in a vertical plane at right angles to this maximum response, called the dip.

The results of these readings are plotted in curve form, one of the curves being shown in Fig. 1. In an

Recovery of Arsenic and Tin in the *Harris Process of Lead Refining*

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IN THE LAST instalment of this description of the Harris process, in the May 19 issue, the manner in which the free caustic soda is separated out of the spent reagent and regenerated for further use was explained. The arsenic and tin are separated therefrom as their crystalline oxysalts in the form of a wet alkaline filter cake, probably also containing some sodium antimonate. This cake may be treated in a variety of ways, the most usual of which is the following:

The crystal cake is treated with hot water, free from lime, in quantity depending upon the composition of the cake as to free caustic soda, arsenic, tin, and antimony contents. The appropriate quantities of water used are set out in Table I and have been calculated so as to furnish a solution containing 10 per cent of combined plus free alkali. A glance at the table will show the disadvantages arising from the production of a wet filter cake in the foregoing filtration operations, for it will be observed that, although with a cake containing 6 per cent of free caustic soda (which is of course present by reason of the presence of adherent solution) it will require about 15 tons of water to dissolve crystals containing one ton of arsenic, the quantity of water used is increased to about 20 tons when the crystals contain 12 per cent of free caustic soda. In the first instance, the final 10 per cent caustic solution produced as a result of the wet treatment of the crystals can normally be absorbed for the solution of spent reagent, and therefore requires no evaporation, whereas in the second instance, considerable quantities of weak solution would have to be evaporated.

Table I

Quantity of water to be added to each ton of arsenic, tin, and antimony, to give a final 10 per cent solution. Column 1 shows per cent free sodium hydroxide (NaOH equivalent of Na_2CO_3) in crystals of As, Sn, and Sb oxysalts.

	Per Cent Kilos of Water Per Ton of—		
	Arsenic	Tin	Antimony
6	15,039	7,324	1,053
7	15,684	7,580	1,296
8	16,399	7,869	1,565
9	17,207	8,188	1,866
10	18,107	8,536	2,205
11	19,119	8,946	2,579
12	20,287	9,413	3,011

Steps in Separation of Antimony, Arsenic and Tin

From the liquor containing the crystals in solution the insoluble sodium antimonate is separated by decantation, as, for instance, in a Dorr thickener, and used as before described. The clear overflow may possibly contain in solution a small amount of antimony, which it is sometimes desirable to remove. This is effected by agitating with either a small quantity of lime or, preferably, powdered tin.

The subsequent operations for the recovery of tin and arsenic consist of the following series of steps:

1. Precipitation of tin by calcium carbonate and separation of calcium stannate precipitate.
2. Partial causticization of the resulting solution with lime and separation of calcium carbonate thus produced.
3. Precipitation of arsenic with lime and separation of calcium arsenate from the resulting 10 per cent solution of caustic soda, which is used for dissolving fresh quantities of spent molten reagent obtained from the dry operations.

In both cases the lime used is freshly slaked with a 10 per cent solution of caustic soda.

Calcium Carbonate a Good Reagent for Tin

1. Calcium carbonate, when present in excess, has the property of quantitatively precipitating tin from alkali solutions of a variety of strengths without precipitating arsenic. Other calcium compounds may be used, provided the solution also contains sodium carbonate. The quantity of calcium carbonate used depends somewhat upon the quantity of free caustic present; but normally about 1.05 times the weight of the tin present is the appropriate amount. The temperature employed is about 90 deg. C. and the action is very rapid. A surprising feature is the selectivity of the reagent for tin. An average analysis of the product over a long period has shown the washed lime-tin compound to contain only 0.068 per cent arsenic, and the fact that the recovery of tin in this precipitate amounted to 95 per cent of the tin originally contained in the lead is a tribute to the completeness of the precipitation. The product finds a ready market.

2. The clear liquor left after the separation of the lime-tin precipitate contains free caustic soda, sodium carbonate, and a little sodium chloride and sodium arsenate. The latter cannot be dissociated with lime in the presence of much sodium carbonate, and hence a preliminary partial causticization becomes necessary. This causticization also serves a further purpose in eliminating from the circuit any carbonate which may be formed in the various operations as a result of the carbonization of caustic soda. When the slurry from the granulating tank is cooled with the object of crystallizing out the arsenic or arsenic and tin oxysalts, sodium carbonate also crystal-

mineralization, which in this particular instance would mean a higher or lower sulphide content of the vein.

Location, Strength of Mineralization, and Dip of Oreshoots

Applying these deductions, location, strength of mineralization and dip of the oreshoots have been plotted on a map (Fig. 3). Connecting the points corresponding to *A* and *B* in Fig. 2 yields lines of maximum positive and negative dips (dash-dot lines), within which the top of the sulphide, when projected to the surface, is to be placed. The points corresponding to *O* have been joined by single and double lines of four different types denoting the varying strengths of mineralization according to the legend in Fig. 3. Where the dip of the oreshoots is vertical or nearly so, these lines coincide with the projected center line of the oreshoot. The dip of the latter is indicated by the ratio of the mutual distance between these center lines and the lines of maximum positive and negative dips. Thus it will be noted that in the vein shown on the right-hand side of the map a change of dip takes place; that is, the vein dips to the southeast at the north end and to the northwest at its south end. The map clearly shows how the strength of the mineralization varies along the veins, thus indicating the distribution of the oreshoots and giving an idea of their relative strength in terms of sulphide content.

Part of the electric survey was executed over an orebody, the north end of which was well opened up by mining and diamond drilling. The outline of the orebody at No. 1 mine-level is shown in Fig. 3 and the dip indicated by the two small arrows. It is apparent that the results of the electrical survey closely check the known facts as far as location, strength of mineralization, and change of dip are concerned. The electrical survey furthermore confirmed the assumption of the management about the strong continuation of the ore toward the southwest, the electrical evidence showing this to be the case for another 500 ft. Beyond that point the survey indicated a sudden decrease in mineralization of the vein, possibly caused by a fault cutting off the ore.

Defining a Fault

To get additional information about this condition a set-up of the sending loop was made at the point marked *X* in Fig. 3, and observations were taken along a series of twelve short lines radiating from *X* and at angles of 30 deg. against one another. The strike variations of the receiving loop were determined, and in plotting points of equal deviations from the survey lines were connected to isogones—shown as dotted lines on the map. These isogones clearly show a distortion striking at about right angles to the orebody, this distortion being interpreted as caused by a fault, which is shown as double dash-dot line on the map. Readings taken in conjunction with a set-up of the sending loop at point II revealed the fact that the vein continued beyond this fault for a few hundred feet, but with very weak mineralization, and that eventually it was lost altogether.

Two parallel veins further to the southwest which could be traced on the surface slightly by a series of old prospect workings and weak outcrops showed only weak mineralization in the electric survey. It was possible, however, to outline one oreshoot in each of them, where a fair strength of sulphide mineralization was indicated. It might have been suspected that these two veins and the strong vein in the northeast were linked together in some way. The electric survey showed that this assumption is not acceptable, in so far as no mineralization could be ascertained in the ground covered by set-up III.

At the northern end of the vein, shown in the northwestern part of the map, it was found that parallel to the main vein a short but strongly mineralized footwall vein was in existence. A check survey by means of set-up III yielded practically the same results as the work previously done in connection with set-up V.

Summarizing the results of this electromagnetic survey in the Ducktown Basin, it may be said that a number of veins were investigated and the location of oreshoots and their dip and relative strength of mineralization were determined. Furthermore, some ground which from geological reasons alone might have been considered promising was eliminated as barren.

Flotation of High-Silica Bauxite

LABORATORY flotation tests on high-silica bauxites made by the U. S. Bureau of Mines, at its Southern Experiment Station, Tuscaloosa, Ala., have given results which compare favorably with results of earlier fractionations made by means of heavy solutions. Indications are that the laboratory flotation machine can be depended on to give a good separation between the clay and the bauxite, provided these two constituents have been sufficiently liberated from each other by crushing, and that the crushing has not produced an excessive amount of slimes.

The principal reagents used consist of sodium sulphide and oleic acid. Recent tests indicate that only a comparatively small amount of these reagents is required for the flotation of the hydrous aluminum oxide minerals. One sample of bauxite recently experimented with showed that an amount of sodium sulphide equivalent to five pounds per ton of ore was sufficient to give a well-sulphidized pulp. Flotation tests of high-silica bauxite are now being made in 500-gram machines, and it is hoped that it will be possible to duplicate the results that have already been obtained with a 50-gram machine.

What Is Needed to Revive Hydraulic Mining in California?

"IN 1888," according to Mr. James D. Stewart, whose analysis of the California hydraulic mining industry is scheduled for an early issue, "about 500 hydraulic mines were operating in the Sacramento and San Joaquin drainage areas. . . . Over $100,000,000 was invested. . . ." Hydraulic mining was stopped by injunctions, beginning in 1881, and the industry was wiped out at a single blow.

The early history of this important branch of metal mining, its effects on contemporary progress, "the intolerant antagonism of its foes and the poor presentation of its own cause," are among the subjects discussed preliminary to a study of the present status of the question, with a plea, if not a demand, for an unbiased verdict and fair treatment from the authorities and the agriculturalists.

of this substance of course very soon becomes apparent.

Causticization is carried out in the third set of agitators, *G*, the calcium carbonate produced being settled in Dorr *C*, withdrawn from the bottom and filtered. The emulsion of slaked lime is fed in gradually through a constant-level tank.

Arsenic is precipitated in the agitators, *H*, and the calcium arsenate settled in Dorr *D*, withdrawn and filtered. In this operation, also, the lime is fed in the form of an emulsion through a constant-level tank. The overflow from the last Dorr is a 10 per cent solution of caustic soda, which is collected in a storage tank and utilized as described before.

Alternate methods of precipitation of the tin, apart from electrolysis, to be discussed later, depend upon the use of carbon dioxide or sulphuric acid; but these methods in general are not to be recommended, as they fail to yield a really arsenic-free product, and, further, the alkali of the sodium stannate cannot then be regenerated.

Instead of using caustic lime for the causticization of the carbonic acid prior to the precipitation of the arsenic, calcium nitrate may be used with the formation of sodium nitrate and calcium carbonate, which latter may be utilized for the precipitation of tin. This has not been found to be economical except under peculiar local conditions. Also, where a market exists for sodium arsenate, the solution obtained after separation of the precipitated lime-tin compound may be cooled and the crystallized sodium arsenate separated by centrifuging. The separated effluent is causticized and returned to the circuit as before. Or, again, the solution of sodium arsenate may be treated with nitric acid and lead nitrate for the production of di-basic commercial lead arsenate. There are, in fact, a number of alternate methods of separating the impurities in marketable form, each more or less applicable only in certain localities.

Instead of using hot water to dissolve the oxysalt cake from the filter press, advantage is taken in some works of the insolubility of sodium arsenate, in comparatively weak solutions of caustic soda, to effect a separation of the sodium stannate at this stage. If there is a fairly high percentage of adherent caustic soda with the filtered crystals, then the addition of a limited quantity of cold water will give a mother liquor which is a weak solution of caustic soda, in which sodium stannate is very soluble, whereas sodium arsenate (and, of course, sodium antimonate) are insoluble. A cold alkaline solution of sodium stannate, substantially free from arsenic, is thus obtained, which may be treated with lime for the production of calcium stannate and caustic soda; with acid for the production of tin oxide (in which event the combined caustic soda is lost); or it may be electrolyzed for the production of metallic tin. The last-named method is most frequently adopted. The residue from the cold-water treatment, consisting of sodium antimonate and sodium arsenate, with perhaps a small amount of sodium stannate, is then treated as before described.

Electrolysis of Sodium Stannate

Where a lead alloy is to be treated that is very high in tin and low in arsenic and with or without antimony, the usual practice is to obtain a filter cake in the normal manner by cooling and filtering the slurry from the granulating tank, to dissolve the cake in water, separate antimony (if present), and to electrolyze the solution of sodium stannate. A small percentage of arsenic does not affect the efficiency of the electrolysis. It is necessary first to remove small quantities of impurities by the addition of sodium sulphide. In one installation where such alloys are treated, the electrolytic tanks contain ten cathodes of sheet tin about 1 mm. thick and eleven anodes of sheet iron, an area of about 28 in. square being immersed in the solution and 6 in. extending above the liquor level. The tank voltage is about 2.2 volts, the current density about 9 to 10 amperes per square foot, and the temperature of operation 90 deg. C. The elec-

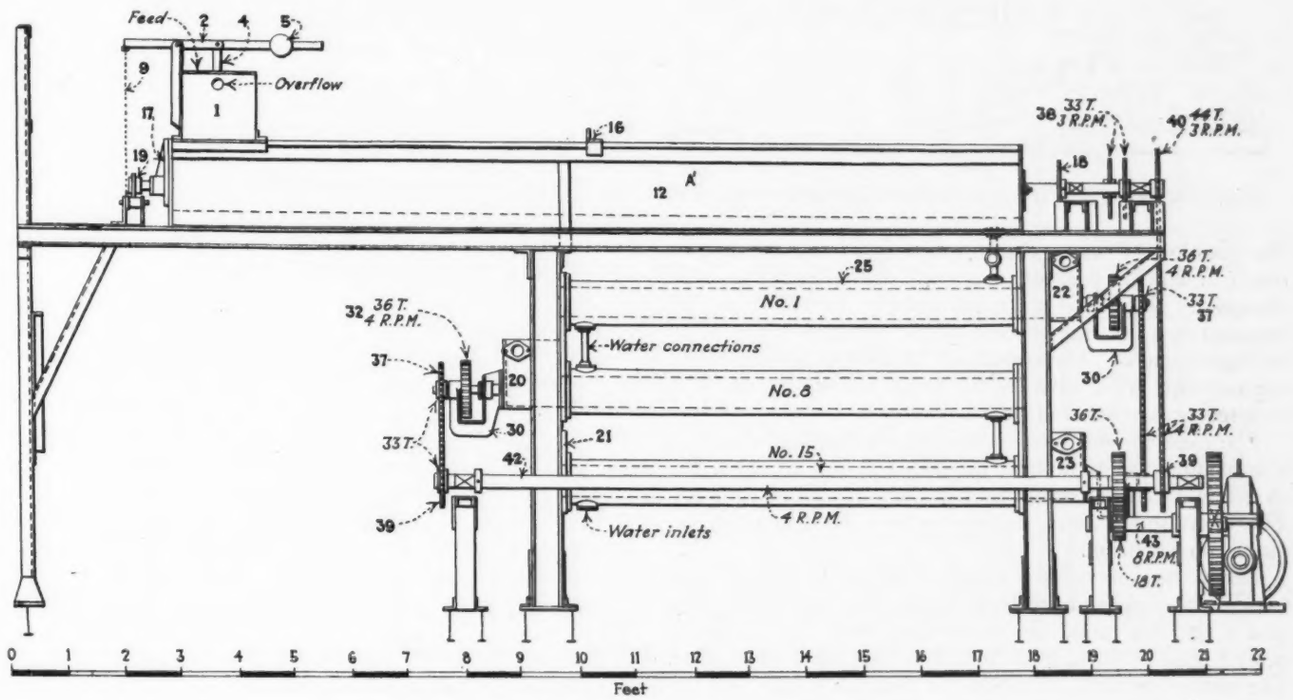


Fig. 2—Special crystallizer for cooling slurry

lizes out and therefore finds its way to the present stage. The causticization is effected in the usual manner with lime freshly slaked in weak caustic solution. The lime emulsion is added gradually, for otherwise it becomes ineffective and the alkalinity of the solution at this point must be such that the free caustic soda plus the alkali in combination as carbonate and in sodium arsenate does not exceed 10 per cent.

3. The arsenic is precipitated as calcium arsenate by the addition to the hot solution of 1.3 to 1.8 lb. of freshly slaked lime per pound of arsenic, according to the product desired. By taking special precautions as to conditions of precipitation, calcium arsenate can be produced which will comply with the specifications governing this material for use as insecticide. When no special precautions are taken, the precipitated material will usually contain about 25 per cent arsenic.

All the operations mentioned in the foregoing may be performed intermittently in tanks, due regard being taken of the necessity, in the precipitation of tin, of keeping the precipitant in excess, which is insured by adding the tin-bearing solutions to the chalk, and not *vice versa*. In the precipitation of arsenic, the reverse condition must be maintained.

For large-scale operations, it is generally preferred to employ the continuous precipitation apparatus illustrated in Fig. 1, designed to reduce to a minimum the working labor and laboratory control usually associated with batch operations. The apparatus is composed essentially of four units placed in cascade, each unit consisting of a four-compartment steam-heated and insulated agitator and a heat-insulated steam-heated and insulated agitator flow of liquor takes place alternately through the agitators and thickeners. Reference is particularly directed to the diagrammatic sketch at the right-hand bottom corner of the illustration.

The first two units are used jointly for the precipitation of the tin in such a way as to insure an observance

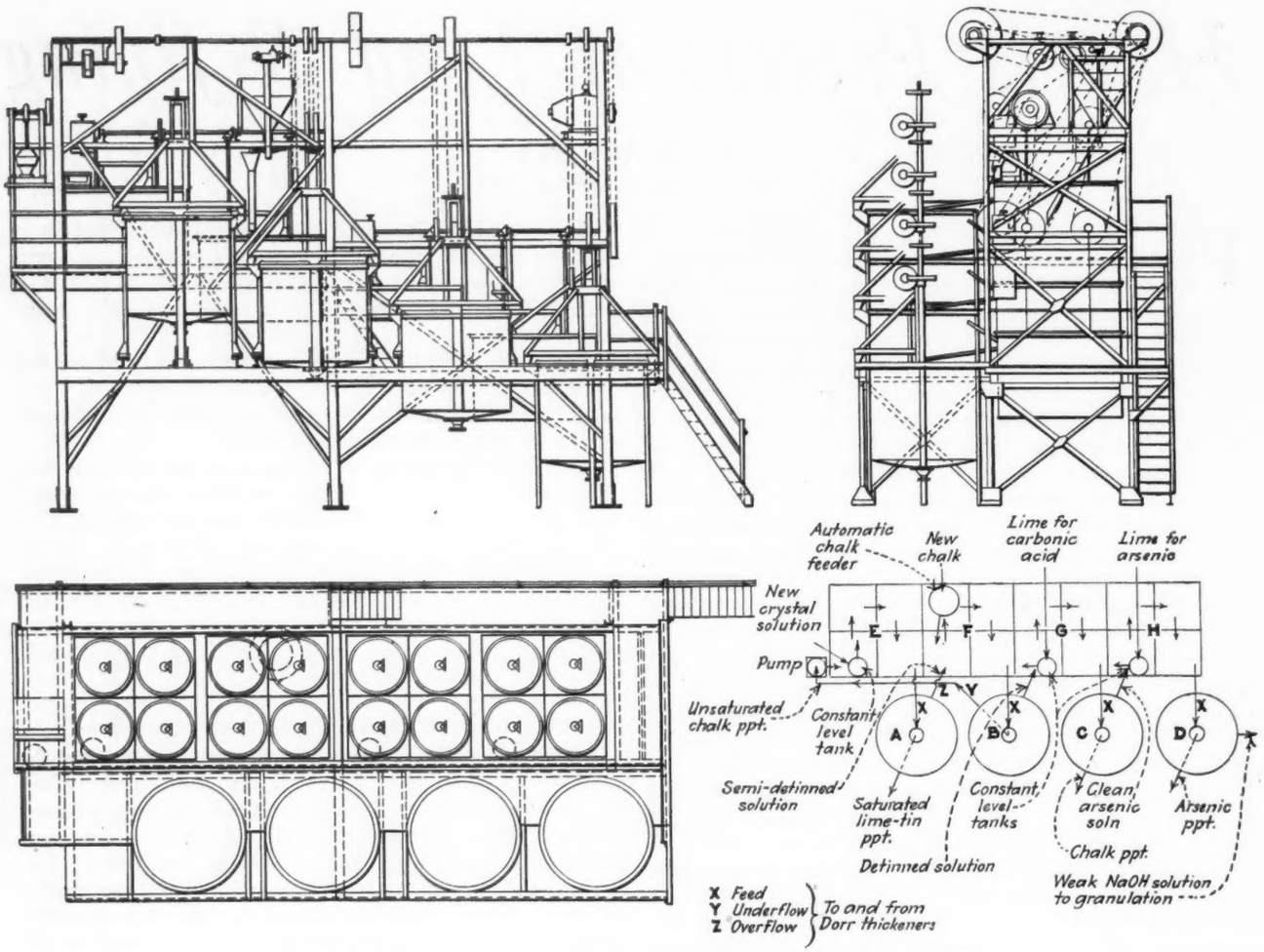


Fig. 1—Continuous precipitation apparatus for tin and arsenic

of the necessary condition that an excess of the reagent shall be present. The precipitant for the tin, calcium carbonate, is fed in considerable excess into the *second* set of agitators F; hence the precipitate produced contains an excess of calcium carbonate, so the solution flowing from the second to the third unit must be tin-free. The precipitate from the Dorr thickener B of the second unit is fed into the first agitator E, together with the original solution, in insufficient quantity to precipitate all the tin. Hence the solution flowing from the first to the second unit contains some tin and the precipitate from the first Dorr thickener A must be a saturated product, which is filtered, washed, and marketed.

Tin precipitation is automatic, because the sole requirement to be observed is that the solution overflowing from the first thickener, A, contains tin, and that overflowing from the second thickener, B, is free of tin, requiring purely qualitative determinations. So long as calcium carbonate is fed in excess to the second set of agitators, nothing can go wrong, and too large an excess

operation is not usually considered desirable or necessary.

The metal flowing from the smelting furnace passes into a mechanical refining or "starring" furnace of special design, from which it is molded and starred. The smelting furnace is not equipped with doors. No iron tools whatever are used; hence, the refined metal is particularly pure, rarely containing less than 99.95 per cent antimony. In one works the metal produced is sold with a guarantee of 99.9 per cent minimum. An average analysis of a very large tonnage of antimony produced at that plant by smelting sodium antimonate gave the following: Sb, 99.964 per cent; As, nil; Sn, 0.015 per cent; Pb, 0.014; and Fe, 0.006 per cent. Exhaustive tests of many samples showed metallic sodium to be absolutely absent.

In his concluding article, to be published soon, Mr. Winter discusses the dry and wet treatment steps of the refining process, whereby the zinc and the last traces of antimony are eliminated from the lead. The advantages of the Harris process are also summarized.

United States Production of Aluminum Registers Slight Gain in 1927

THE value of new aluminum produced in the United States during 1927 was $39,266,000, an increase of 4 per cent compared with 1926, according to a statement prepared by J. M. Hill, of the U. S. Bureau of Mines. The principal producing plant was that of the Aluminum Company of America at Massena, N. Y., where approximately half of the metal made in the United States was recovered. Other works are at Niagara Falls, N. Y.; Alcoa, Tenn.; and Badin (Whitney), N. C. The control dams on the Yadkin and Little Tennessee rivers, in North Carolina, were completed.

The domestic price of new aluminum ingot 99 per cent pure, as quoted by the *Engineering and Mining Journal*, says the Bureau of Mines, was 27c. a pound during the first half of January, 1927. On Jan. 15, the Aluminum Company of America lowered its price to 26c., which held until Oct. 20, 1927, when a further cut to 25c. a pound was announced, which price remained in force to the end of the year. The average quoted price for the year was $0.2584 a pound. Prices of metal 98-99 per cent pure offered by other interests were from 0.2 to 0.7c. per pound less than figures given by the Aluminum Company of America, and it seems probable that a fair average price for all new aluminum sold in 1927 was $0.254 a pound.

In spite of curtailed production of automobiles, the use of aluminum and high-strength aluminum alloys was large, particularly for pistons and reciprocating parts of automotive engines. Aluminum powder for paint pigment was more extensively used, and the use of aluminum foil increased materially. Use of aluminum for collapsible tubes for pastes and greases is relatively new, but is growing. Aluminum shingles and corrugated sheet for roofing and siding, which were introduced recently, were more widely used during 1927 than previously. More aluminum was used in the manufacture of furniture, airplanes, railroad and street cars, and motor buses.

Imports of aluminum metal, scrap, and alloys in 1927 were 72,188,518 lb., or 4 per cent less in quantity than in 1926. Imports of manufactured aluminum were but 542,775 lb. Exports of aluminum in unmanufactured and semi-manufactured forms amounted to 16,052,175 lb.

Iron and Aluminum Ores—Relations of Supply and Demand

By Edwin C. Eckel
Washington, D. C.

THE CLOSE geologic relationship of iron and aluminum ores has long been recognized, and with the present shift of attention toward the naturally mixed ores containing both metals, their intimate industrial relationships must attain equal recognition economically. The brief summary in this article covers certain interesting points of both relationship and comparison which are not commonly noted in purely technical discussion of the subjects. These points are tabulated, and a few of the lines in the table which require fuller explanation are noted in the present text.

At the outset, of course, we have the facts as to original abundance of the two metals and of their oxides. The data on these points stated in the two top lines of the accompanying table are taken from Clarke's "Data of Geochemistry"; the relations in the last column are merely my own restatement of those facts in a comparative light. As a constituent of the earth's crust, aluminum, whether calculated as element or oxide, is far more common than iron.

As an economic material the case becomes more complicated, owing chiefly to the fact that although we use iron minerals almost entirely as ores of iron, we are increasingly using aluminum minerals for non-metallic purposes. Whenever we speak of aluminum ores as scarce, we are limiting attention to the less important (that is, metallurgical) uses of the aluminum minerals. And even with such limitations accepted, we are prone to overestimate the actual scarcity of those ores. Several lines in the table suggest the truth on that point.

Table I—Comparisons of Iron and Aluminum Ores

	Iron	Aluminum	Ratio, Fe/Al
Natural abundance, earth's crust:			
Calculated as oxides, per cent	6.82	15.23	1:2
Calculated as elements, per cent	5.06	8.07	1:1.6
Probable world ore reserves:			
Millions of tons	91,500	2,500	36:1
Annual consumption of ore, M. T.	136	1¼	110:1
Duration (reserve ÷ draft), years	700	2,000	1:3
Annual output of metal, 1925, tons	67,400,000	180,000	375:1
Growth of output, 1913–1923, per cent	Decrease 12	Increase 225	.....
Average price, cents per lb.	0.75	25	1:33

The differences, as to uses, of the two series of minerals is brought out sharply if we tabulate those which are actually now utilized for any industrial purpose whatever.

Mere inspection of the preceding tabulation calls attention to the fact that though over 99 per cent of the iron minerals mined are used directly or indirectly in making iron and steel—the small exception being chiefly pigments—by far the bulk of the aluminum minerals mined do not even remotely touch on the making of aluminum metal. This is true even if we restrict consideration to the bauxites, where only about a third of the output goes

Table II—Iron and Aluminum Minerals in Industrial Use

Compound	Iron Only	Iron + Aluminum	Aluminum Only
Anhydrous oxides	Magnetite, hematite	Emery	Corundum
Hydrous oxides	Brown ores (limonite, turgite, goethite, xanthosiderite, limonite)	Ferruginous bauxites, laterites, aluminous brown ores	Bauxite ores (diaspore, bauxite, gibbsite)
Carbonates	Siderite	.....	.....
Sulphates	.....	.....	Alunite, alunogen
Sulphides	Pyrite, pyrrhotite	.....	.....
Phosphates	.....	.....	Wavellite
Fluoride	.....	.....	Cryolite
Silicates	Thuringite Chamoisite	Glauconite	Kaolinite Halloysite Normal clays

trolyte is covered with a thin layer of paraffin wax to prevent oxidation and evaporation. Fifty such tanks are required for a production of one ton of tin per 24 hours. The spent electrolyte is caustic soda. It may be somewhat carbonated and may be causticized if necessary before being returned to the cycle of the process.

The cooling of the slurry obtained by the water treatment of the spent molten reagent can be carried out in a variety of ways, but preferably in a crystallizer of continuous type. Where the predominant material to be crystallized is tin, and water consumption is of little consideration, any trough type of conveyor crystallizer such as the Swenson can be used; but for works where

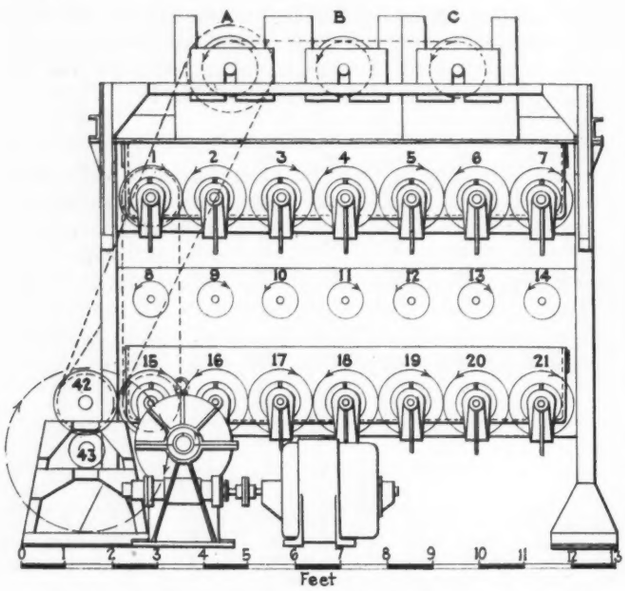


Fig. 3—End view of crystallizer shown in Fig. 2

the question of water consumption is of importance, or much arsenic is present, a special crystallizer has been designed. It consists fundamentally of four superimposed sets of water-cooled screw conveyors, as shown in Figs. 2 and 3. The conveyors of the top set are of the open-trough type, whereas the three lower sets work in inclosed water-jacketed tubes.

The mass to be cooled is pumped continuously through a constant-level tank into the top row of troughs, the overflow from the tank falling back to the feed tank. The operation is thus continuous and the apparatus requires no attention.

Below the conveyors is a tank designed to hold at least two hours' supply of the chilled mass from the conveyors, and from this tank the mass may flow direct into a centrifugal dehydrator or into the feed tank of a filter. The entire machine, exclusive of the centrifuge and the pump for delivering the hot liquor to the top troughs, is driven by a 5-hp. motor. The conveyors rotate at about 4 r.p.m.

Machine capacity depends, of course, to a great extent upon the composition of the liquor to be cooled, because of the heat of crystallization of the oxysalts. The machine shown in the sketch is capable of cooling from 150 to 300 imperial gallons per hour from 90 deg. C. down to the crystallization point. As to the quantity of water required, it of course also varies; but in this respect the machine is remarkably efficient.

The solution to be evaporated, which is the filtrate from the filter press which removes the oxysalt impurities, is always of constant composition, containing both caustic soda and sodium chloride. Its evaporation in the ordinary type of steam evaporator is not practicable, because of the salting out of the sodium chloride which takes place under such circumstances. The system which has given the best all-round results involves the continuous feeding of the liquor, heated to its boiling point, into a flash boiler of cast iron in the form of a kettle, provided with a hood and a device for collecting the entrained liquor. This apparatus is illustrated diagrammatically in Fig. 4. The alkaline solution is pumped from its storage tank by way of a condenser to a constant-level preheater, where the liquor is heated to boiling point by waste gases from the evaporating kettle or by the evaporated steam. Consumption of coal is about in the proportion of 1 lb. to 4¼ lb. of water evaporated.

The operation is simple and requires little attention once the rate of feed of liquor is adjusted so that evaporation is instantaneous. A kettle 5 ft. in diameter will evaporate approximately 40 to 45 U. S. gallons of water per hour. The bottom of the kettle is protected by a bath of lead and the kettle consumption is very light. The great advantage of the system is that a mixture of caustic soda and sodium chloride is always available in a molten fused condition for direct transport to the Harris softening machine. .

Athough the reduction of this material is quite simple and takes place at a comparatively low temperature, consideration must be given to its poor conductivity and its extremely fine state, which conditions combined necessitate the use of a very small depth of charge. The material, mixed with its appropriate reducing agent—namely, fine coal and a little sulphur—is continuously fed onto the sloping sides of a specially designed reverberatory furnace. The temperature is maintained at about 750 deg. C. and the reduced metal flows toward the tapping hole of the hearth. When it is desired to tap the furnace, but not until then, the temperature is raised to above the fusing point of the carbonate of soda slag.

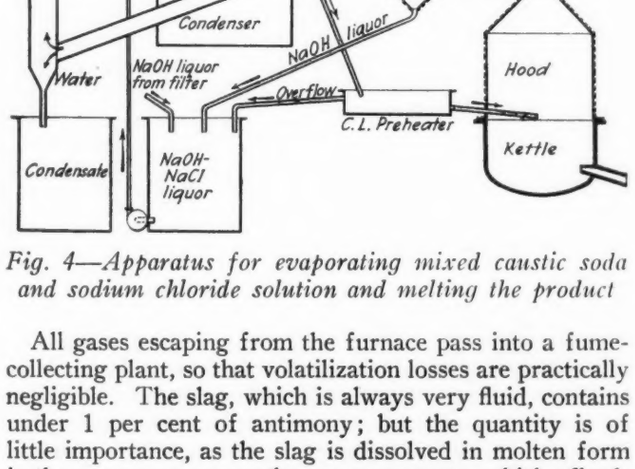


Fig. 4—Apparatus for evaporating mixed caustic soda and sodium chloride solution and melting the product

All gases escaping from the furnace pass into a fume-collecting plant, so that volatilization losses are practically negligible. The slag, which is always very fluid, contains under 1 per cent of antimony; but the quantity is of little importance, as the slag is dissolved in molten form in the same manner as other spent reagents, which affords opportunity for recovering any antimony that it may contain. Hence, the recovery of antimony is very nearly perfect. If desired, the slag solution may be causticized for the recovery of sodium hydroxide, but in practice this

into metal. With the rapid growth of the alumina cement industry, the disproportion between metallurgical and non-metallic demand will become even more striking each year in future. Yet even from the metallurgical standpoint, where there is economic reason for accepting only high-grade ores, the outlook is far from discouraging when we consider reserves, known and probable, of such ores.

Estimates are now available, in each case by well-known geologists, of the commercial-grade bauxite reserves known to exist in France, Rumania, Hungary, and Montenegro, in Europe; of Nyassa and Gold Coast colonies, in Africa; of Arkansas, in North America; of New South Wales, in Australia; and of British India, in Asia. Here only nine countries and colonies are represented, out of all the world, yet the total of the estimates for these nine amounts to 290,500,000 tons of commercial-grade bauxite known today. It will be seen that the countries represented omit such large current producers as British and Dutch Guiana and Dalmatia. South America is not, in fact, represented at all in the published estimates; North America is represented by only one state; Australia by one state; and Africa by two very small colonies. Yet even this fragmentary evidence is ample to prove that bauxite is not by any means a rare mineral, or even a scarce mineral; it is, in cold truth, one of the most common minerals in the world.

To extend our knowledge to cover the vast areas still unestimated, it will be well to adopt a method which has been used elsewhere[1] in estimating the probable iron-ore reserves of the world, as being equally valid here. In doing this we assume that on our best-known continent—which in the case of bauxite happens to be Europe—we have no geological reason whatever for expecting to find exceptionally rich bauxite deposits. The fact, on the contrary, is that Europe is probably *less* rich than most of the other continents, since it has no tropical regions and hence no recent bauxitic laterite formation. Yet for the purposes of our present calculations we will assume that Europe is entirely representative, geologically, of the world in general; and that the rest of the world, when searched with equal care, will be found to contain bauxite deposits in about the same ratio of tonnage to area.

Now, in the case of Europe, we have, today, known bauxite fields containing at least 200,000,000 tons of commercial bauxite ore. Since the total area of Europe is a little less than four million square miles, its known bauxite averages somewhat over 50 tons per square mile of *total* area. If we then extend this ratio to the less-known portions of the world, we see that the probable bauxite reserves of the different countries are approximately as given in Table III.

Table III—Bauxite Reserves

	Tons		Tons
Europe	200,000,000	Africa	600,000,000
South America	350,000,000	Asia	800,000,000
North America	400,000,000	Australia	150,000,000
		World total	2,500,000,000

This total, of 2,500 millions of tons, is a convenient figure to remember, and it is probably close to the truth: if North America (including Cuba of course) is rated high, Africa and South America are per contra rated too low.

Since the whole world is at present consuming only some 1½ million tons of bauxite annually, it will be seen that anxiety over impending scarcity of the ore can safely be put off for the next fifteen hundred years. And if, instead of estimating tonnages of alum- and alumina-grade bauxites, we included the high iron laterites which are best for the new alumina cement industry, our world total would be at least doubled, and perhaps multiplied by ten or more.

These ideas as to probable reserve supplies can then be taken into consideration along with the facts as to growth of the demand, as shown in the main table. We are obviously dealing with a group of minerals which will increase immensely in industrial importance, but of which we have, fortunately, entirely ample supplies. The comparisons as to metal outputs, rates of increase over a recent decade, and prices per pound of metal—all these are of interest, but require no detailed explanation.

[1]Iron Ores. Eckel, E. C. New York, 1914. Pp. 392-393.

Engels Copper Mill Operations for 1927

THE following statistical recapitulation of mill operations of the Engels Copper Mining Company, Plumas County, Calif., appeared in the company's annual report, recently issued:

Average copper assay of heading, per cent	1.788
Average copper assay of tailing, per cent	0.193
Average copper assay of concentrate, per cent	14.470
Indicated copper recovery, per cent	89.84
Actual copper recovery, per cent	88.14
Copper in concentrate produced, pounds	12,121,756
Difference between copper in heading and tailing, pounds	12,355,245
Insoluble in concentrate, per cent	32.96
Material on 100-mesh, per cent	12.89
Average lime used per day, barrels	3.8646
Average lime used per 100 tons of ore milled, barrels	0.364
Average tons of ore settled per barrel of lime	259.19
Ratio of concentration	17.435 to 1

	Total for 1927	Average per Ton of Ore Milled
Balls (5 in.) used, pounds	490,440	1.2759
Balls (2½ in.) used, pounds	326,480	.8487
Total balls used, pounds	816,920	2.1237
Liners used, pounds	155,324	0.4038
Flotation reagents used, pounds	227,628	0.5917
Lime used, barrels	1,399	0.00363
Ore crushed, tons	384,462	.....
Ore crushed, average per day, tons	1,062	.....
Concentrate produced (dry), total, tons	22,063.52	.....
Concentrate produced (dry), average per day, tons	60.95	.....

The average ore crushed per day is computed on an actual operating year of 362 days. The tonnage of ore milled for the year is 319 tons greater than the tonnage crushed, which, reduced to the daily tonnage basis, makes a difference of less than one ton per day.

Inspiration Consolidated Copper Company Leaching Data

DURING 1927 a total of 2,967,949 dry tons of ore was crushed and charged into Inspiration's leaching tanks. This tonnage represents 349 leaching charges or an average of 8,504 dry tons per tank.

The metallurgical results from 349 charges, leached and excavated, were as follows:

	Per Cent
Feed	
Total copper	1.056
Oxide copper	0.718
Sulphide copper	0.338
Tailings	
Total copper	0.188
Oxide copper	0.059
Sulphide copper	0.129
Extractions	
Total copper	82.197
Oxide copper	91.783
Sulphide copper	61.834

The operation of the leaching plant was satisfactory. Costs obtained were lower than the estimated costs.

COMMENT AND CRITICISM

New Concentration Methods in the Batesville-Cushman Manganese Field of Arkansas

THE EDITOR:

Sir—The application of new methods in ore dressing and concentration may increase the ore reserves of a mining field with the same surety as the discovery of entirely new orebodies. This has been demonstrated in the Batesville-Cushman manganese field, in Arkansas, by L. B. Miller and W. G. Rinehart, who have been operating an experimental plant for 2½ years, on chocolate clay, of which there are extensive bodies throughout the section. These are residual deposits. It had been known for many years that this clay carried manganese, but until experiments were started by Miller and Rinehart it was never considered of commercial value.

The ores of the field were classified as boulder and wash ore. Boulder ore is found in the clay, from the size of an egg up to pieces weighing several hundred pounds. Wash ore consisted of clay carrying small particles of manganese, which could be saved with an ordinary hand or power jig. The clay was considered an obstacle to operation, for it was hard to dissolve, balling up in the log washers and giving considerable trouble.

An analysis of these chocolate clays, by Miller and Rinehart, disclosed the fact that they contained manganese running from 10 per cent up, in the form of minute particles of ore of 200 mesh and finer, not visible to the naked eye. It is this fine ore that gives the clay its chocolate color. With this knowledge in hand, they undertook to find a method of recovery. The present experimental plant, 4 miles north of Batesville, is probably the only plant of its kind in existence in any manganese field today.

The mine is a large open pit in ore-bearing clay, on the side of a hill, 100 ft. above the plant. In this pit the clay is mined with a ⅝-yd. steam shovel, and goes to a flume in which it is carried by water to a slush pit at the mill. A considerable part of the solubles are carried off in this process. Mixed with water in the slush pit, the clay is reduced to a heavy slime. It is pulled from the pit with a drag line into a set of 30-ft. logs, where almost all the solubles are removed. From this set of logs the solids are passed through a ¼-in. revolving screen, the oversize going to a belt conveyor, known as the picker belt, where it is removed by hand, the remainder going to a settling tank. From the settling tank it passes through a set of 16-ft. logs and from these through a ⅛-in. revolving screen. The oversize from this operation goes through a set of 36-in. rolls, and back to the settling tank, the undersize being sent to a No. 11 Wilfley table for concentration. From the table the clean ore is passed by belt conveyors to a bin, where it is thoroughly drained. After all the water is drained from the ore it is fed into a rotary cement kiln, 60 ft. long and 4 ft. diameter, where it is subjected to a temperature of 1,200 deg. F., which sinters it. It comes from the kiln in the shape of dry clinkers, from the size of a pea to that of a baseball, and is ready for immediate shipment to the furnaces.

The operation has been experimental, and many changes have been made in the plant. In order to reduce local hauling costs and freight, it was decided to put out a moistureless product. An ordinary rotary drier was first installed, but the product was not suitable for the furnaces. It was so fine that the blast carried a portion of it out of the stack. It was then decided to sinter it, and a cement kiln was used, which has been working satisfactorily. The furnace heat penetrates into every crack and crevice of the clinker, and it is easily smelted.

The tonnage that this development has added to the ore reserves of the field is enormous. To arrive at anything like an accurate estimate, a survey of all these clay deposits would have to be made, and this would be a long and arduous task, for the field, partly in Independence County and partly in Izard County, is 10 miles wide and 20 miles long. Commercial deposits of manganese have been recently discovered in Stone County, and it is known that many large deposits of chocolate clay are also present there. Some operators hazard a guess that these cholocate clays compose 25 per cent of all the surface formations in the field. To me, as one familiar with operations for the last quarter of a century, it seems the most important development made. Yet, after all, it finally evolves itself into the question as to whether or no, by this method, ore can be abstracted from these clays at a profit. Mr. Rinehart, who has been actively in charge of the experiments, says that operations can be carried on profitably at the present price of ore.

TOM SHIRAS.

Mountain Home, Ark.

[Mr. Shiras' initiative in bringing this development to our notice is appreciated. Mr. Miller has been good enough to supplement the account with additional details, which we append herewith—EDITOR.]

Our work so far has been largely experimental. The materials on which we have been working are clays residual from the Fernvale limestone, which lie in the upper part of the Ordovician series. Reference to these clays is usually made as being brown or chocolate colored, and in them is found a moderate number of lumps of high-grade manganese ore. Reports on this district by geologists and examining engineers commence as far back as 1858, according to H. D. Miser, in his Bulletin No. 734, of the U. S. Geological Survey. During the last seventy years there is record of much work having been done, in the attempt to mine and ship ore of high grade, but no finely divided ore has ever been separated from the clay commercially. These clays are generally overlaid by mountain wash consisting of chert and other barren material; they lie above water level and are easily accessible, and overlie the irregular surface of the Fernvale limestone. There has been no difficulty in the past in securing high-grade ore from them, the procedure being to discard the clays and save only the lumps.

The work of Mr. Rinehart and myself disclosed the fact that where one ton of lump ore has been saved from the clays, the clays themselves contain from 37 to 38 times as much ore, very finely divided, as they contain in the shape of lump ore. This finely divided ore, however, is not as high grade as the lump; it analyzes about as follows, at 212 deg. F.:

	Per Cent
Manganese	28.00
Iron	20.00
Silica	12.00
Alumina	5.00
Lime	6.00
Carbonate of barium	3.50
Phosphorus	1.00

The extent of these ore-bearing clays, as reported by Mr. H. D. Miser, is 2 to 4 miles in width and about 25 miles in length; at least this is the territory he examined. It is not at all improbable that the deposits are much greater in extent; they are found 50 miles

farther west than the most westerly of Mr. Miser's examinations. It is not improbable, therefore, that the clays are of enormous extent. In a not very remote way there is a similarity between this deposit and that of iron ores in the Mesaba range district in Minnesota.

Up to this time it is evident that no effort has been made to save the fine ores from these clays; nothing but the lump has been mined heretofore, except for moderate amounts of wad that have been shipped from time to time, and are now being shipped, but the quantity of this wad is evidently not of very great extent. The predominating supply of material in this district lies in brown, red, and chocolate-colored clays. The method of winning the fines, as devised by Mr. Rinehart and myself, is by dissolving or emulsifying the clays by free application of water while the clays are being agitated, and separating out the fine ore by gravity. This involves several washings and scrubbings, after which the ore is dried and then sintered, ready for shipment.

The character of the fine ore derived from these clays is such that, in its present condition, it is not suitable for making ferromanganese or spiegeleisen, but is suitable only, in its present condition, for adding manganese to the ore burden in making pig iron. But the quantity of the ore is so enormous that it is likely to play a very important part in the future supply of ore for use in this country, when beneficiated by some of the processes now being worked out, for making high-grade manganese product from the medium grades.

Cleveland, Ohio. L. B. MILLER.

* * *

The Microscope and Metallurgical Losses

THE EDITOR:

Sir—Your editorial in the May 12 issue calls attention to the practical value of microscopic research in metallurgy. You say that "Relatively little is known of the mineralogical form in which losses in tailing occur. Such losses usually are determined by chemical or fire analysis, which reveals little as to the mineralogical composition of the tailing and nothing concerning its physical characteristics."

I should like to call attention to some mineralogical conditions which were met with in treating the copper ore at Cananea, Mexico, and which could not have been determined except by microscopic study. The sulphide ore at Cananea contains varying amounts of pyrite which the operators desired to eliminate from the concentrates. During a series of tests made by Mr. A. T. Tye, assistant superintendent of the concentrator, the discovery was made that with the increased amount of pyrite dropped in the tailing there was an increased loss of copper. A microscopic examination of the concentrates and tailings was carried on by the geological department with the object of determining the ore and gangue minerals and their relation to one another. Search was also made for non-metallic minerals which might act as coatings and thus interfere with flotation.

The results of this investigation showed that much of the copper loss was due to the presence of chalcopyrite and bornite, which occurred as inclusions in the pyrite and as adhering particles both to the iron sulphides and to fragments of the gangue minerals. Finer grinding was found to be all that was necessary to liberate the included and adhering minerals.

The microscope also showed that sericite, which is abundant in some of the ore, formed a coating on the copper sulphides, thus increasing the tailing loss. Experiments are now being carried on with the object of eliminating this latter difficulty.

GRAHAM JOHN MITCHELL.

New York, N. Y.

* * *

Geophysics in Japan

THE EDITOR:

Sir—I am one of many who would express thanks for your endeavors to encourage mining and metallurgy throughout the world. I have been interested in the articles published concerning modern geophysical prospecting methods. As you will doubtless be interested to learn of developments in other countries, I have the honor to inform you that the Nippon Electrical Prospecting Company has been working in Japan since the fall of 1926. The general manager is S. Miyata, and K. Ishigaki is mining geologist.

Osaka, Japan. K. ISHIGAKI.

* * *

Begins Study of Landslides

THE EDITOR:

Sir—Studies of landslides in unconsolidated materials are being begun at the University of Cincinnati with the intention of determining causes and of considering such factors as angle of slope, soil saturation, and mode of movement. We should especially appreciate hearing from readers of *Engineering and Mining Journal* who know of the location of landslides in unconsolidated material in the states east of the Mississippi. In writing, please address James K. Rogers, Fellow, Department of Geology.

C. H. BEHRE, JR.,
University of Cincinnati,
Cincinnati, Ohio.

* * *

Xanthate and the Perkins Patents

THE EDITOR:

Sir—The *Engineering and Mining Journal* of April 7 in an article in the editorial column has seen fit to use my name in connection with the recent decision of Judge Bourquin in the xanthate suit of the Metals Recovery Company versus the Anaconda Copper Mining Company, in which it questions if any one, *even myself*, ever expected that the Metals Recovery Company could win the suit on the basis of the Perkins patent, "which in effect tried to blanket about 300,000 organic compounds in a wide domain into which Perkins had ventured little—to use the phrase of the Court." There are also in the editorial two other quotations from the court decision which read as follows:

"Furthermore, the effectiveness of xanthate when used in flotation with a frothing agent had been discovered and made known in January-August, 1915, long prior to Perkins, by Martin."

"His experiments and tests were equal to Perkins' prior to application for the patent in suit, and all agree such tests suffice for transfer to mill operations. Of this, the evidence without conflict leaves no reasonable doubt."

I cannot but feel that your information is from prejudiced sources. Perkins did not try to blanket 300,000 organic compounds—he purposely put into his claims for invention four limitations in order to direct any one skilled in the art toward those he considered represented his discovery and away from those that did not. He said they must be (1) non-oleaginous (2) non-frothing, (3) mineral collecting, (4) reduced and easily oxidizable. Is it possible to be more specific than this or more technically correct in a domain so widely diversant as organic compounds? That seemed to him and to us to clearly specify the particular area his reagents occupied.

Read the story of Perkins research work at the Mellon Institute as reported month by month in his formal reports; it is now a court record and therefore public property, and I say, and you will have to admit, it is as fascinating a story of a painstaking piece of research and invention as has ever been told. Compare it then with the documents in the Martin allegations, the rambling and incoherent statements, the half-baked experiments, the vast majority of which were so little impressive, even to Martin or his employers, that no assays of the products were made. Remember also that this information, such as it was, lay buried in the archives of the Utah Copper Company and the Minerals Separation company for twelve years, and was then unearthed after Metals Recovery Company and Perkins had demonstrated to the industry the value of his discovery, solely for the purpose of beating him out of the credit and profits of his invention.

Of the same order as this Martin story is another that may be news to some. It also is a court record and therefore public property.

This relates how an assayer, working in a San Francisco laboratory, got the idea that potassium xanthate might make a good flotation agent, so he prepared some and asked a fellow worker to try it out on some ore. On further questioning in court he stated that he had not heard, read, or thought of potassium xanthate during the previous thirty years. The one previous occasion when he had heard or thought about the

compound was on a day thirty years before when he happened to be walking along the banks of the Rhine and saw some farmers spraying their grape vines with an evil smelling substance which they told him was potassium xanthate. For economy of effort in producing an extremely valuable contribution to industry, I think this man holds the record.

Perkins' contribution to the art of flotation is of a high order, and few seem to have appreciated the full significance of the results that have followed in the train of his discoveries. Here is an illustration of the mistake that a modest man can make of keeping his light under a bushel; it also illustrated the truth of the homely saying "there is not much use to grind unless you advertise your grist."

Perkins discovered that there exist certain non-oleaginous, non-frothing, organic compounds which, when introduced into an ore pulp, imparted to the particles to be floated certain properties quite separate and distinct from anything that had ever been recognized before, and known as collecting properties, and that this collecting property was absolutely separate, distinct, and independent of any frothing property, and he pointed out for the first time that the froth of the frothing process, instead of being a predominant characteristic and essential of the flotation process, as it has long been considered, was purely a secondary and mechanical one. He disclosed and made public—and I emphasize *made public*—this single-minded collecting power of that certain class of organic reagents and their function of preparing mineral particles for flotation as distinct and separate from the function of producing the froth which was to float them to the surface. This discovery of Perkins' marked an epoch in the flotation of ore. Nobody can deny this. There were the days of oils before Perkins, and the days of chemical reagents since Perkins. Will any one take issue with me?

The dawn of the use of chemical reagents started with X-cake at the Magma Copper Company in the early part of 1917. This was Dr. Corliss' discovery, and Perkins and Sayre were his associates in the research work established by the Metals Recovery Company at the Mellon Institute in 1915. Up to that time oils *only* were in use, and by oils I mean not a narrow interpretation or the quibbling interpretation that interested litigants would like to put upon it, but I mean any flotation agent other than chemicals. Without detracting in any way from the original discovery and development of the flotation process or belittling in the slightest degree the extraordinarily valuable contribution of the inventors in the art up to this time, I cannot but refer to this period except to describe it as a period of hit and miss and a period of pure empiricism. The practice of the art at that period always reminds me of the practice of the Chinese physician or the horse doctor of the past generations who introduced into the mixtures that their victims had to swallow every conceivable drug that they were cognizant of, the more nauseous the better, and the greater the number the more likelihood that one of them might hit the mark. Another simile expressive of the oil flotation practice which I think is apt is that it was about as reasonable as sweetening your morning cup of coffee with half a sugar beet. The contrast of the practice before Perkins with that which exists today after Perkins is truly astonishing. It is only those who have actively worked in both fields who can fully appreciate the enormous advance that has been made as a result of Perkins' original discovery.

The results that we see around us today and the results that have been accomplished, and the extraordinary strides that have been made since chemicals were first substituted for oils at the Magma Copper Company in the early part of 1917, are all directly traceable back to this research work at the Mellon Institute initiated by the Metals Recovery Company and carried on by Dr. Corliss and Mr. Perkins and Mr. Sayre. It has created a revolution in the art, comparable only with that created by the original development of the process. It is of the same magnitude as the introduction of the air-drill in mining, the steam-shovel in railroad work, and the advent of the Wilfley table in the wet concentration of ores.

I know whereof I speak, for I have been a spectator of all these developments and an active participator in the development of flotation practices, and, in a humble way, with every step in its changing phases and also with every step in the development of the Perkins invention. I went through with him and his associate, and the late Dr. Corliss, all the various mental steps and processes by which the climax was reached when the Perkins' patent was formulated and for the first time disclosed to the public. And I say here without hesitation that no more unwarranted, more unjust, or more unkind statement was ever made than that contained in the sentences quoted in the *Engineering and Mining Journal* of April 7.

It seems appropriate here to quote from the opinion by Judge Grier expressed in a famous case involving the Goodyear patents, because he expressed, in words quite beyond my ability to devise, a situation with regard to inventors which is altogether too true in these commercial and rapacious days:

"It is when speculation has been reduced to practice, when experiment has resulted in discovery, and when that discovery has been perfected by patient and continued experiments—when some new compound, art, manufacture, or machine has been thus produced, which is useful to the public—that the party making it becomes a public benefactor, and entitled to a patent.

"And yet when genius and patient perseverance have at length succeeded, in spite of sneers and scoffs, in perfecting some valuable invention or discovery, how seldom is it followed by reward? Envy robs him of the honor, while speculators, swindlers, and pirates rob him of the profits. Every unsuccessful experimenter who did, or did not, come very near making the discovery, now claims it. Everyone who can invent an improvement, or vary its form, claims a right to pirate the original discovery."

The commercial side of this situation may or may not be lost through the intricacies of the law; let that pass. It is a subject for the lawyers. But I cannot stand by any longer and see a good man's work and efforts crucified. And I call upon the *Engineering and Mining Journal* to make it its business to interest itself in the true story and the facts surrounding the use of chemical reagents in place of oils in the flotation industry; and to make it its business to determine the full nature of Perkins' contribution to that industry, not taking any one man's word for granted and no judge's opinion for gospel; and then, through the columns that have helped belittle these men, to make appropriate amends.

F. M. CALLOW.

New York.

[*Engineering and Mining Journal* disavows any intention or desire to withhold credit from Mr. Perkins for the work that he accomplished in introducing the so-called "chemical" reagents, in distinction to those that are described as oleaginous. We do not believe that anyone will deny that Mr. Callow and his associates were the first to make practical use of flotation reagents of this character. As to the question of xanthate, specifically, the record is not quite so clear; although from a legal standpoint the decision in the suit to which Mr. Callow refers should help operators of flotation plants to determine their status with respect to liability for royalties as users of xanthate. The editorial to which Mr. Callow takes exception necessarily mentioned the Perkins patents, but the point that we wished to make was that the recognition of the Martin reports on the use of xanthate in 1915, as a valid defense against claims of infringement, sets a precedent that must have a bearing on any claims of Minerals Separation for license to use xanthate under the Keller patent. Unless and until the decision of Judge Bourquin is reversed—and attorneys say that a reversal on findings of fact is unusual—it is difficult for the non-legal mind to see why the use of xanthate is not open to all without payment of royalty to anyone. Mr. A. A. Cook, of Minerals Separation, intimated in a letter published in the issue of May 12 that the question of the validity of the Martin defense will be further threshed out in the courts by his company.

As to Mr. Callow's request that *Engineering and Mining Journal* determine the "true story and the facts surrounding the use of chemical reagents," those familiar with the industry will admit that this would prove a "large order." We are always glad to give publicity to pertinent comment on the subject, as to all matters of comparable interest.—EDITOR.]

Consultation

Wohlwill Process of Gold Refining

"I am seeking information on an electrical process for the refining of gold. Have you ever heard of the 'Wohlial' or 'Wihlewal' process? Can you give me any information on this process?"

You undoubtedly have in mind the Wohlwill process of Dr. Emil Wohlwill. This process is used at many of the copper refineries for the purification of the byproduct gold from blister copper. In this process, according to E. J. Wagor's "Refining of Gold and Silver Bullion," Vol. 2, Liddell's Handbook of Non-Ferrous Metallurgy, the electrolytic cells are of porcelain, usually 16 in. long, 11½ in. wide, 12 in. deep, inside measurements, arranged in batteries of 12 to 15 cells. Electrode supports are of porcelain or hard rubber, steel-reinforced rods, covered with strips of gold for conducting the currents. The anodes are cast with a hole in the top and suspended from the anode supports by C-shaped gold hangers or hooks. The cathodes are strips of fine gold rolled out to a thickness of 0.01 in. and cut to proper length. These starting sheets are annealed to present warping or buckling in the cell, care being used not to soften the turnover which supports the weight of the deposited gold.

The electrolyte is a solution of gold chloride containing 50 to 60 grams of gold to the liter, with 5 to 7 per cent of free hydrochloric acid. It is kept uniform by circulation, using an air pump, or agitation furnished by glass propellers.

The current used is a pulsating or non-symmetrical alternating one, obtained by connecting a direct-current generator in series with an alternating-current source, which may be either an alternating-current generator of proper voltage, or a high-voltage source stepped down by use of an induction regulator. The refining can be done by direct current alone, but the pulsating current makes possible the refining of gold bullion containing a higher percentage of silver at higher current densities and with less free acid. This current and its application and advantages are described by the inventor, Dr. Emil Wohlwill, in patent literature on this process.

The current density used is from 50 to 70 amp. per square foot of cathode surface, and the ratio of alternating to direct current is determined by the silver content of the anode. Under current action, the anodes, which contain from 8 to 10 per cent of silver, are dissolved, the gold as well as the platinum metals, together with the base, passing into solution, while the silver is changed to insoluble chloride and falls to the bottom of the cells. Osmiridium crystals in the anode are not affected by the current and fall with the silver chloride. An excess of silver in the anodes forms a coating of chloride, which protects them from further action, thus rendering them practically insoluble, and an evolution of chlorine results. The gold deposited at the cathode is very hard and quite dense, and the starting sheet is melted with the deposited gold. Frequently the melts will run to 999.9 in fineness.

As the base metals are dissolved at the anode the gold content of the electrolyte drops, and it is necessary to add strong gold chloride at intervals. To take care of the depletion of gold in the electrolyte, a stock of strong gold chloride must be kept constantly on hand. This chloride is made either by dissolving fine gold bars or granulations in aqua regia, or electrically, by passing a current through an electrolyte of concentrated hydrochloric acid, using anodes of fine gold and fine cathodes suspended in a porous porcelain cell.

About 5 per cent of the gold treated falls mechanically into the silver chloride slimes. The reduction of the silver chloride is effected by use of granulated zinc in porcelain tanks, sufficient acid being present to start the action. After reduction is complete, the slimes are thoroughly washed in a filter or centrifugal machine and melted directly into anodes for the silver-refining cells. These slimes will average, in fineness, from 250 to 500 parts of gold, 30 to 40 parts base, balance silver, and in the melting sufficient gold or silver bullion is added, as required, to produce an alloy of the fineness required by the silver-refining operations. The gold in the spent electrolyte and wash waters is recovered by precipitation with ferrous sulphate or by scrap copper. As gold so recovered is in a very fine state of division, and difficult to melt and wash without loss, an electrolytic recovery is to be preferred.

All the foul solution from which the silver and gold have been recovered is pumped into large wooden tanks containing scrap iron, in which the copper is recovered as cement copper, and any gold, silver, or platinum metals which have escaped the previous operations are recovered. To recover the values in this cement copper a small electrolytic copper plant is operated, producing pure copper and a sludge containing the precious metals. The sludge is a veritable dragnet of impurities, containing besides Au, Ag, and Pt, the base metals Cu, As, Sb, Pb, Bi, and others. This is usually handled in small amounts in silver-anode melts, and the precious metals are recovered from the regular process.

By the Way

Mark What This Lamb Did!

THE president and chief engineer of the New York Steel Exchange, who recently was low bidder on a ten-mile tunnel for the national Argentine government, has recently completed an interesting tunnel job in Uruguay, according to report. It is believed to be the only job of its kind, and certainly the only one described in *E.&M.J.* Through the entire length, the tunnel was in soft, running, damp sand. Much of it had to be built first as an open cut, to be afterward covered with reinforced sand. The open cut was easy, the difficulty being to find reinforcing material for the cover. Ordinary newspaper proved a failure, and it was fortunate that only a part of the work was completed with this material. The failure of this section resulted in no loss of lives. An exhaustive search and series of tests demonstrated that the oiled paper used for wrapping sandwiches was ideal. Long strips were anchored well back from the tunnel, and by crimping the ends and laying the strips double, the roof of this 12-in. tunnel was successfully finished. It immediately received a decisive test, which was successfully resisted. A sand snipe ran the full length of the tunnel catching sand fleas, but caused absolutely no damage. After completing other less extensive but similarly important works, Mr. and Mrs. Mark R. Lamb abandoned the beach at Punta el Este for Buenos Aires, not, however, without taking with them the plain evidence of the energetic actinism of the Uruguayan sun.

When the Man Bit the Dog

CHARLES A. DANA, of the old New York *Sun*, once established for all newspaper men a distinction between what is news and what is not news. When a dog bites a man it is not news, but when a man bites a dog, it is news. We append, as the prime news note of the week therefore, the following paragraph from the Salt Lake *Mining Review:*

"The Park Bingham Mining Company has collected approximately $21,000 from George Graham Rice, mining promoter, through settlement reached a few days ago on a judgment secured in a New York court last summer. The Park Bingham company secured the judgment on a $15,000 note which Rice gave the company for stock which he is alleged to have sold and pocketed the money. The additional $6,000 was collected for interest and attorneys' fees."

INDUSTRIAL PROGRESS

Eliminating Breakage in Hollow Drill Steel

An Investigation and Its Results

A DETAILED STUDY of the life of rock drill steel has recently been conducted in the mines at Hofors, Sweden, under the supervision of L. Nordenfelt. Although it has not yet been completed, some important points have been developed. The following data regarding it, taken from the reports of the engineers of Swedish Charcoal Steels, Inc., are presented by Sixten F. Wollmar, vice-president of the company.

By examining all fatigue breakages of the steel which have so far occurred in the test it has been conclusively proved that when a rock drill of the self-rotating type is used all breakages of this kind start from the surface of the hole in the hollow steel. It has further been proved that the rough hole surface—that is, the marks left by the indentations of the sand core—are the starting points for the fatigue cracks and that the corrosive action of the water has a very detrimental influence on the life of the steel. It is now a well-known fact that this corrosive action concentrates at the bottom of the indentations left by the sand.

It has been demonstrated that oxygen is an important factor in the cause of pitting, but that the corrosion did not proceed over those portions of the surface which could be readily reached by oxygen. It is, therefore, clear that the corrosive action must be very strong at the bottom of the indentations, especially

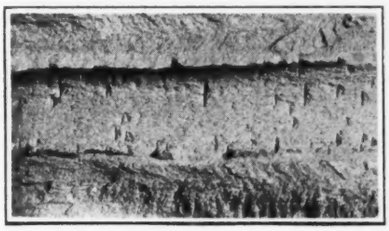


Fig. 1—A piece of hollow steel, split transversely, which has been in work for some time, but has not failed as yet

when the pits are protected from the direct action of the water by the deposit with which they are filled.

Experiments have shown that slight corrosion simultaneous with fatigue may cause failure at stresses far below the ordinary endurance limit. It is also shown that severe corrosion prior to fatigue lowers fatigue resistance much less than slight corrosion simultaneous with fatigue. It is further proved by corrosion fatigue tests that at low-cycle frequency specimens fail after much fewer cycles than at high-cycle frequency. This is evidently due to the increase in corrosion time per cycle with decrease in cycle frequency. Moreover, although with a decrease in cycle frequency the number of cycles before failure decreases, the total time until failure increases. The relationship between corrosion time and cycles until failure is of practical importance because it explains mysterious failures at stresses below the endurance limit and after a small number of cycles.

In a paper read before the American Society of Steel Treating, by D. J. McAdam, Jr., and published in the *Transactions* of that Society, Vol. XI, No. 3, March, 1927, page 355, Mr. McAdam expresses the opinion that the corrosion fatigue limit depends on a strength factor as well as on corrosion resistance. He further describes and illustrates the corrosion fatigue spots and is of the opinion that transverse cracks passing through non-metallic inclusions, usually surrounded by oxide coating, are the origin of corrosion-fatigue failure. It is clear, therefore, that it is necessary to employ the highest grade of steel in the manufacture of hollow drill steel to get a high modulus of elasticity and freedom from detrimental non-metallic inclusions.

To demonstrate fully the importance of what has been said in the foregoing paragraphs, microphotos of some typical fatigue cracks are given. Fig. 1 shows a steel which had been in work for a considerable time, but which had not yet failed. When the steel was split, the hole surface showed a great number of transverse cracks, all of which started from indentations left by the sand which had been enlarged by the corrosive action of the water.

Fig. 2 shows a section around the hole with a typical fatigue crack. Such cracks appear in fracture as a smooth flat surface and are often wrongly described as "flaws in the steel." From the graduation of the color of the crack it is, however, obvious that they radiate, starting from a point on the surface of the hole, and it is clearly seen from this photo that the starting point has been an indentation caused by the sand.

Fig. 3 shows the cracks under higher magnification and confirms that they start at the bottom of indentations.

If a drill steel has failed in service because of fatigue, it is not as a rule economical to re-shank it and to put it into further service. The explanation of this fact is evidently that when a steel in such a condition is put into service, some of the cracks will grow very rapidly and cause a new failure in a short time.

From the investigation of the fractures of broken steel it is obvious that transverse cracks are responsible for the majority of the breakages of drill steel,

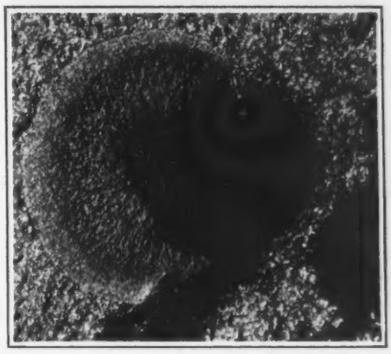


Fig. 2—A section around the hole with a typical fatigue crack

for they appear in great numbers in practically every fracture of a drill broken in service. Corrosion is also an important factor in the cause of cracks.

From the foregoing it is clear that if the wall of the hole can be made smooth in addition to being non-corrosive, the steel should give longer life. Among the many ways of attempting this, the method of lining the hole with a tube of soft iron, "Armco" iron, or rustless iron seemed to offer the best solution. Steel of this type, manufactured both by Swedish and English steel makers, has been tried out on a large scale in South Africa, but the results were a total failure. Examination of such steel revealed that the iron tube had formed an absolute weld with the steel, thereby defeating the very purpose for which the tube was inserted—namely, to obtain a smooth hole surface. Therefore merely a steel with a soft core resulted, and as the steel is rolled by the original sand core process, the hole surface is very rough, and as the soft iron tube is not non-corrosive, the steel must fail in service just as badly as or worse than the original sand-core steel.

If steel, manufactured according to this process, is to prove successful, it is absolutely necessary to prevent the tube from becoming welded to the steel. However, if this could be avoided, the

aim of obtaining a smooth surface of the hole is accomplished. This steel could not, however, be used for any drills where shanking is necessary, as when forging the shank the tube will tend to close the hole. The steel is, therefore, useless for machines other

Fig. 3 — Fatigue crack more highly magnified

than those using anvil blocks, but even then trouble may arise unless great care is exercised when forging the bit to prevent closing of the hole.

The Copper-Core Method

Another method, producing an absolutely smooth hole surface, thus reducing the starting points for corrosion fatigue cracks, as well as mechanical fatigue cracks, has been used for several years—the copper-core method. It has been proved by actual underground tests that, although of the same analysis, the copper-core steel gives longer life before fracture than steel rolled by the original sand-core process. However, when fracture does occur, the copper-core steel shows a very badly pitted hole surface, which is due to corrosion. When examined, the typical tranverse cracks are found at the bottom of these corrosion pits. This is illustrated in Figs. 4 and 5, which show a piece of copper core steel in longitudinal section. The piece in Fig. 4 is new, and that in Fig. 5 has been cut from a steel which had been in actual service for a time somewhat longer than one month.

The corrosion is due to small flakes of copper which adhere to the hole surface when pulling the copper rod out of the finished bar, and which form electrochemical cells with the steel, thus causing strong corrosive action at these spots. The copper-core steel would, therefore, most likely give an excellent result if it were possible to obtain the smooth hole surface without the adhering copper.

The very inconsistent results obtained with the copper-core steel are probably not only due to lack of uniformity in the steel used in manufacture, but also to the variable amounts of copper adhering to the hole surface.

Judging from the results obtained from actual underground tests, it is quite clear that up to now neither the non-corrosive tube-lined steel as hitherto manufactured, nor the copper-core steel, has proved a complete success.

Experiments in Sweden

For a period of some years the SKF Hofors Steel Works have been experimenting with different manufacturing processes, and the resulting steel has been tested in the Hofors mines. The different points discussed herein have been taken into consideration in working out the new processes. The main features of this new hollow drill steel are:

1. The material used consists of high-grade charcoal steel, which gives a high modulus of elasticity and is as free from solid non-metallic inclusions as it is possible to make a steel, thus giving the steel itself high resistance to corrosion.
2. The steel is manufactured with either smooth or super-smooth hole surface, which eliminates the starting points for corrosion cracks as well as mechanical cracks.
3. The hole surface is free from material which may induce corrosion.

Small Hole in Steel Advantageous

A test of interest was carried out with steel from the same heat and manufactured by the same process, but with holes of different sizes. It demonstrated that a steel with a small hole is stronger than one with a large hole.

If the rock cuttings are not ejected as rapidly as they are disintegrated at the bottom of the drill hole, the drilling speed will decrease and the reduction of bit gage due to the abrasiveness of the rock cuttings will increase.

The test carried out with drills of different hole diameters showed that the drilling speed is increased and the loss in gage due to wear decreased when using a drill with a small hole.

For sludging the drill holes, water under pressure from 20 to 150 lb., or compressed air, or a mixture of both, is used. The water is conducted by a hose line to an axially mounted water tube in the back head of the machine, which extends through the hammer piston and enters the shank of the hollow drill steel for a distance of 2 to 3 in., by which it is conducted to the bottom of the hole being drilled. This arrangement with the water tube is unfortunately very often used as an objection to a small

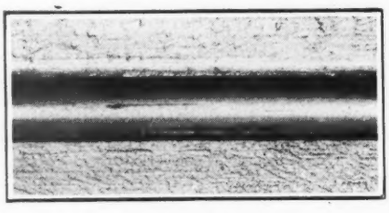


Fig. 4—A piece of copper-core steel, in section, new

hole. The blacksmith objects because it means perhaps a little more work for him to keep the hole in the shank to the desired dimension during the shanking operation. If this is not done, the miner will object because a hole in the shank that is too small will cut or wear out the water tube in a short time.

Modern American drill-sharpening machines, however, are provided with such facilities for keeping or opening the hole in the shank to the right dimension that it practically means no increase in work or skill to forge a proper shank provided with a hole large enough for the water tube, even if the hole in the steel itself is smaller than the hole desired in the shank.

Testing Pointers

Even if the same type of rock drill is used for all the different brands of steel, there may be changes in their perform-

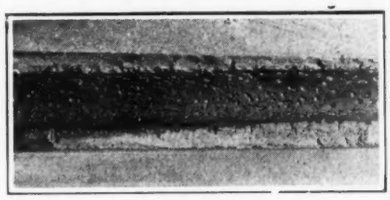


Fig. 5—A piece of copper-core steel that has been in use about one month

ance due to wear and tear and to different air and water pressure available at the working places. The result is a variation of force and frequency of the hammer blow, of rotation torque and revolutions per minute of the drill steel, and of the drill-hole-cleaning facilities, all of which have a great influence on the results obtained with the drill steel.

Another important point to be borne in mind when carrying out such a test is that the life of the steel depends upon the kind of work it has to do, such as drifting, stoping, sinking, or raising. It must also be remembered that the analysis of the steel, especially the variation in carbon content, as well as the human element, affects the results obtained.

High-head Pump Successful, Larger Size Ordered

AFTER having tested two No. 8 Cameron HV pumps over a two-year period and under operating conditions on the 1,780 level of the Park Utah mine, at Park City, Utah, with highly satisfactory results, the Park Utah Consolidated Mines Company has ordered another pump of this type, but in an appreciably larger (No. 10) size. The new pump, according to the manufacturer, the Ingersoll-Rand Company, has a rated capacity of 4,500 g.p.m. against a total discharge head of 304 ft., as compared with a capacity in the No. 8 size of 2,700 g.p.m. against a total head of 285 ft. The No. 10 pump will be direct-connected to a 500-hp. motor. Its design will embody minor improvements.

The tests made with the No. 8 pumps by the Park Utah company showed them to have an efficiency of 78 per cent when equipped with new rings. Efficiency declined as the rings wore, but was restored immediately to 78 per cent by

installing new rings. Under factory tests these pumps developed an efficiency of 79 per cent; they were guaranteed by the manufacturer to show 78 per cent efficiency.

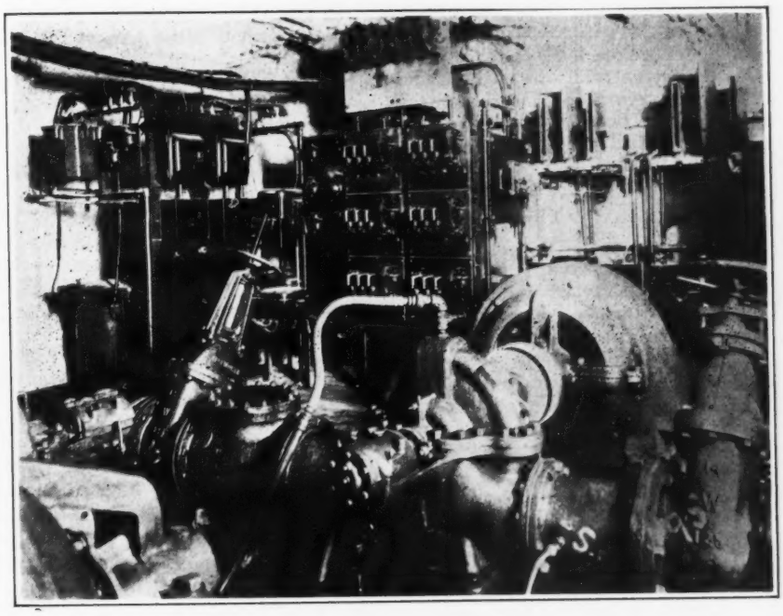
An efficiency of 85 per cent has been guaranteed for the new pump. On the basis of its past experience the mining company expects that the unit under operating conditions will develop the guaranteed efficiency when equipped with new rings. Every ten weeks the rings will be changed, at the end of which period, it is estimated, the efficiency of the pump will have declined to 80 per cent. The average operating efficiency of this unit is, therefore, expected by the Park-Utah company to be 82½ per cent.

The Cameron HV pump is a high-head, single-stage unit. It is built in a number of sizes with capacities ranging from 100 to 30,000 g.p.m. for heads from 175 to 300 ft. It can be arranged for direct connection to either motor, steam turbine, or gasoline engine. Sizes No. 8 and 10 (and larger) are equipped with separate bearing bodies and self-aligning bushings. A center-collar type Kingsbury thrust bearing maintains alignment of the rotor and takes care of any thrust that may be set up under operating conditions.

The upper half of the casing can be quickly and easily removed without disturbing the bearings or pipe connections. It is provided with a balancing port, so arranged that variations in pressure on either side of the impeller will be equalized, eliminating possible thrust. All passages are of such design as to prevent abrupt changes in the velocity and direction of the water, thus contributing to the high efficiency that the pump has shown under test.

The pump is of strong construction throughout and particularly suited for mine drainage duty. The performance of the new and larger unit will be watched with interest.

High-head pump, in use in Park Utah mine, shows high efficiency under test



The Equipment Review

MACHINERY and tools recently introduced by manufacturers for mining and metallurgical purposes are of a varied nature. Salient features, as reported by the maker, are given in the following digest:

Compressors

Ingersoll-Rand has added a seventh size to its line of portable air compressors. The new machine has a 4¾-in. bore and a 4-in. stroke, with a piston displacement of 82 cu.ft. per minute. It is driven by a four-cylinder tractor-type Waukesha motor. It may be had with truck or trailer mounting or without running gear for mounting on skids, railway cars, or the like.

Conveyors

A new face conveyor, called the "Jax," has been introduced by Link-Belt Company, 910 South Michigan Avenue, Chicago. This conveyor is built primarily for the coal industry. It is not impossible, however, that applications of it can be made in other mining operations. The conveyor is made light enough for one man to move it easily and hurriedly. It is mounted on agricultural-type wheels 14-in. in diameter. It comes in two sizes—namely, 12 ft. in length, weighing 640 lb., and a 15-ft. size, weighing 710 lb. The belt that carries the material is supported underneath by a steel plate with skirt boards to prevent spillage. Height of discharge can be adjusted. Anti-friction bearings are used and all gears run in grease.

Caterpillar Mountings

To meet the severe service to which the crawler parts of cranes, tractors, shovels, trenchers, and excavators are subjected, the American Manganese Steel Company has developed a number of parts to resist wear and breakage. These include one-piece crawler treads, rollers, bushings, pins, hunting tooth split-rim sprocket wheels, split-rim self-cleaning sprocket wheels, front idlers, upper track rollers, double-flanged lower rollers, and single-flanged lower rollers.

Welding

Torch—A torch which may be used either for cutting or for welding without changing the tip has been introduced by the Alexander Milburn Company, 1416 W. Baltimore St., Baltimore, Md. It has a tip of a convertible type. Conversion is accomplished simply by turning the tip. In one position the gases are automatically passed through the preheating gas passages while the high-pressure oxygen is carried through the central hole for cutting. In the next position, made by a quarter turn of the tip, the cutting oxygen is cut off and the welding gases are conveyed through the central passage of the cutting tip, making a perfect welding flame. This torch is known as the Type TI.

Motors

Automatic Braking — General Electric has introduced an automatic brake for use with a super-synchronous motor, which does away with manual braking of the rotating stator. Desirable features of hand braking are retained, it is claimed. The brake mechanism consists of an upright standard, which supports a vertical shaft, the lower part of which is threaded. On revolving, the shaft transmits motion through a trunnion block to a series of levers attached to the brake band. The brake motor is mounted on a side of the standard and is geared to the screw shaft. When the brake is being released, the trunnion block travels upward on the screw and is stopped by the tripping of a limit switch when sufficient clearance has been obtained between the brake band and the motor frame. In tightening the brake, the trunnion block moves down on the screw, automatically applying tension to the brake band until the action is again stopped by a limit switch. It is impossible to apply more torque than the amount corresponding to the weights on the brake lever. By adjusting these weights the starting time of the motor may be varied over a period of from 5 to 40 seconds. With this brake, it is asserted, there is no sudden application of torque to the driven ma-machine, even when the brake is set for rapid acceleration. Slipping caused by shocks produced by the load when it is up to full speed can also be prevented. Typical applications of the brake are: centrifugal and other pumps where by-pass connections are omitted; air compressors where unloading valves are omitted; vacuum pumps; mine fans and other large blowers; crushing, grinding, and pulverizing machinery, and all machines that are difficult to start when stopped loaded with material.

NEWS OF THE WEEK

Summary

CONGRESS adjourns without having passed much legislation on mining matters. Senator Oddie may introduce a resolution at the next session authorizing investigation of the fitness of the Budget Director's staff to pass on technical legislation. Page 907.

* * *

Teck-Hughes may add a 300-ton unit to its plant at Kirkland Lake, bringing the total capacity up to 1,150 tons daily. Production for the first quarter broke all mine records. Page 909.

* * *

Three of the principal platinum-producing companies in the Transvaal may be absorbed by Potgietersrust Platinums, according to an agreement now pending. Page 910.

* * *

B. & B. Quick, operating near Tonopah, Nev., is installing a 50-ton furnace plant, which should be ready for operation by July. The property has produced about 300 flasks of quicksilver in the last year. Page 911.

* * *

The Hartley mill of Interstate Zinc & Lead is being reopened to handle old tailing dumps of Chanute Spelter at Baxter Springs, Kan. Page 908.

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Appellate division of federal court reverses Justice Bourquin's decision in Carson-Anaconda suit. Injunction and accounting ordered. Page 907.

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Fire at the Dos Estrellas mines near El Oro, State of Mexico, has caused suspension of operations at the property and forced 3,000 men out of work. Page 910.

* * *

Hollinger investigation is completed by Justice Godson. Report indicates lack of co-ordination between management and workers resulted in dumping refuse underground and led to disastrous fire. Page 907.

New Strike at Lonely Reef Augments Rhodesian Gold Output

Property in Southern Rhodesia Was Generally Considered Exhausted, but Developments on the No. 12 Level Have Shown 100,000 Tons of 50 Dwt. Ore

REMARKABLE developments have recently been recorded on the No. 12 level of the Lonely Reef gold mine, in the Bubi district, Southern Rhodesia. The Lonely is the deepest quartz mine in Africa—a vertical depth of 4,050 ft. having been reached on the 33 level at the bottom of the mine. These new discoveries have had a most stimulating effect on Rhodesian gold mining generally. The mine was thought to be exhausted, but the new discoveries show the presence of 100,000 tons of 50-dwt. ore. Public opinion is, in consequence, more than ever inclining to the belief that many other Rhodesian mines have closed down too soon, and that, with a little more intelligent exploration and prospecting, results similar to those obtained by the Lonely might have been obtained at various other properties.

Working conditions at the bottom level of the Lonely Reef had become so difficult—the rock temperature at the face was 102 deg. F.—and the ore had become so scarce, that the end of the mine appeared to be in sight. Having abandoned the idea of finding paying values at the bottom, Mr. van Eyssen, the company's consulting engineer, set his mind on exploiting the No. 12 level again. During 1927, 6,919 ft. of development work was carried out. Of the footage developed 5,141 ft. was on the reef. Commercial ore was found over 1,156 ft., averaging 25.24 dwt. for a width of 34.6 in.

Efforts to locate an oreshoot at depth having failed, the drive south on the No. 12 level, where rich mineralization had previously been found, was reopened. The drive had caved in, but when it was cleared the first few blasts disclosed a rich shoot, which so far has revealed a tonnage of 100,000 tons of an average value of 50 dwt. over a stoping width of 71 in. This estimate does not take into consideration the possibilities of the levels above and below the No. 12.

The following are the results for the last 25 ft. sampled:

Position	Dwt.	Width, Inches
1,060	69	115
1,065	72	98
1,070	89	109
1,075	95	76
1,080	98.5	59
1,085	90	36

For the last three positions the reef has not been fully exposed. Should the present good showing continue, it will probably be decided to sink a two-compartment vertical shaft to the No. 12 level, as the present working conditions of haulage underground, by means of a disjointed vertical-incline shaft, do not permit of economical operation.

An extensive program of underground prospecting with a Sullivan diamond drill is about to be undertaken. This drill is capable of exploring to a depth of 800 ft. and marks, perhaps, a new era in the exploration of Rhodesia's auriferous deposits.

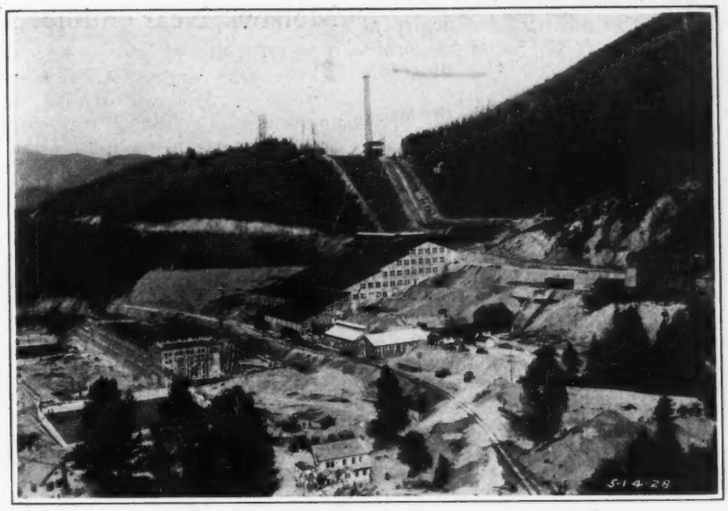
East Standard Mining to Dimond Drill Property

AT A MEETING of the board of directors of the East Standard Mining Company held in Salt Lake City on May 25, it was decided to employ a diamond drill in the development of the company's property, which adjoins the Tintic Standard in the east section of the Tintic district of Utah.

The work, according to J. F. Quist, president of East Standard, will begin on the 500 level of the 700-ft. shaft on the property. From this point, which is at the water level, drilling will be conducted to a depth of 1,000 ft., or further, if necessary, to determine the geologic structure below the shaft. This drilling will be followed by either additional drilling, or by deepening the shaft, depending on results obtained.

Mineralized fissures, productive in the Eureka Lily, North Lily, and Tintic Standard properties in the district, extend into the East Standard, and it is believed that if these fissures can be developed in limestone below the rhyolite covering the property, ore deposits will be encountered.

The company is adequately financed to carry on this work, and no assessments are to be made in connection with the present development of the property.



Sullivan Electrolytic Zinc Plant on May 14

ON THE RIGHT is the terminal of the wire-rope tramway from the Pine Creek mine to the new electrolytic zinc plant of Sullivan Mining. The upper railroad spur extends to the Arizona tunnel and the lower to the Bunker Hill smelter. The steel flue to the stack is under construction and is the last important piece of work necessary to complete before the plant can be placed in commission. *E.&M.J.* presents the picture through the courtesy of F. W. Bradley, president of Bunker Hill & Sullivan.

Congress Adjourns Without Passing Needed Mining Legislation

By Paul Wooton
Special Washington Correspondent

THE FIRST session of the 70th Congress adjourned without having done very much for the mining industry. Such progress as was made by mining legislation is not lost, however, as bills do not die at the end of a session as they do at the end of the Congress. The work can be resumed where it was left off in the short session of the 70th Congress, which will convene Dec. 4.

As far as mining is concerned, the principal activity of the session was in connection with the effort to increase the amount of fundamental research which the federal government is doing on problems pertaining to mining. This includes several bills providing for the creation of new experiment stations or the expansion of those now in existence. The Senate Committee on Mines and Mining held an important hearing on the subject, at which a valuable record was built up. The demand for printed copies of the hearing has been large and has come from nearly every state in the Union and from many foreign countries.

The effort to extend the jurisdiction of the Court of Claims to include claims filed under the War Minerals Relief Act passed the Senate and was reported favorably by the House Committee on Mines and Mining, but no opportunity was given to consider it on the floor of the House.

The Senate Committee recommended the passage of a resolution which would have made possible the revision of the foreign exchange and currency statistics which were published originally as a part of the work of the Commission of Gold and Silver Inquiry. The filibuster in the Senate made it impossible to get action on that legislation.

As the Bureau of the Budget was the principal obstacle in the path of mining legislation at the session just closed, Senator Oddie, Chairman of the Senate Committee on Mines and Mining, is considering the introduction at the December session of a resolution authorizing the Senate to investigate the members of the staff of the Director of the Budget to determine their individual fitness to pass on technical legislation.

Anglo-Chilean Deficit —Erratum

Our London correspondent, in the issue of May 26, p. 871, states that the deficit at the end of 1927 of the Anglo-Chilean Consolidated Nitrate Corporation was $3,898,000, compared with $2,243,000 at the end of 1926. The figures are in error. The deficit on Dec. 31, 1927, was $6,141,104, as compared with $2,243,319 at the end of 1926, as shown on p. 876 of the same issue.

Eureka Standard Strikes High-Grade Silver-Gold Ore

By Telegraph to "Engineering and Mining Journal"

SALT LAKE CITY, May 28, 1928.—High-grade silver-gold ore, averaging 8 ft. in width, has been encountered on the 1,100 level of the Eureka Standard mine, in the Tintic district of Utah. The discovery is one mile south of the Tintic Standard No. 2 shaft. The area is in the eastern part of the Tintic district and had been unproven to date. Considerable geological importance is attached to the discovery. The deposit has been followed 15 ft. in virgin territory. The first carload of ore from the Eureka Standard will be shipped this week. Ore will be hauled on the 900 level to the Tintic Standard No. 2 shaft and hoisted.

Eureka Standard is controlled largely by the Tintic Standard Mining Company, one of the largest and most consistent producers in the Tintic district. Most of the Tintic mines produce a silver-lead ore, with small quantities of gold. The district is about 100 miles from Salt Lake City, and ore is shipped for treatment at the smelting plants there.

Carson Wins Over Anaconda

The United States Appellate Court, sitting in San Francisco, on May 28 reversed the decision of Justice Bourquin in the litigation between Carson and Anaconda Copper Mining Company, and remanded the case with directions to the lower court to award an injunction and proceed to an accounting. Judge Dietrich dissented from the majority opinion, contending that the Carson and Siemens ideas are the same. Further details of the decision will be published in the issue of June 9.

Central Eureka to Open New Level at 4,850 Ft.

CENTRAL EUREKA, at Sutter Creek, Calif., is preparing to open a new level, the 4,850. Stoping is being done at the 4,500 and 4,700 levels. In the Old Eureka ground, a crosscut is being driven to cut the "railroad vein." A good orebody, 100 ft. in length, was drifted upon in the Old Eureka vein on the 1,500 level. Work has started to cut this oreshoot on the 1,800 level, 300 ft. below.

Local reports credit the Argyle Mining Company, a Nevada corporation that operated at Hamilton, Nev., with having acquired control of the Royal mine, at Felix, Calif., west of the Mother Lode in Calaveras County. Recent attempts to work this property have not been noteworthy, but the new company is reported to be operating twenty stamps of the 120-stamp mill. Two shifts are being worked at the Sacred Mount mill above Sierra City, Calif., and a transmission line is being surveyed from the Monarch power house, the intention being to operate mill and compressors by electric power.

Reopened Tri-State Mill Will Handle Tailings

TO TREAT old tailing dumps, made while the property was operated by Chanute Spelter, the Hartley mill of the Interstate Zinc & Lead Corporation, located west of Baxter Springs, Kan., in the Joplin-Miami district, has been reopened. Radical changes in regular Tri-State practice will be made in the mill. Hand sorting of ore, never practiced before in the district, will be introduced in an effort to reduce mining costs. These changes will cost between $50,000 and $75,000, according to C. F. Dike, manager.

All ores from the field shafts will be automatically dumped into a surface hopper. At the bottom of the hopper, which will be in a pit about 50 ft. deep, an 18x36-in. crusher will be installed. This crusher will reduce ore to minus 4 in. The ore will go from the crusher onto a conveyor belt that will carry it to a sorting house, where the largest pieces of waste can be eliminated. It will then pass over a flat, 2-in. shaker screen, another innovation for the district, after which it will be thoroughly washed. Two picking belts, 36 in. by 20 ft., will carry the ore to the waste dump. A large number of men will pick the ore off these belts. It is believed that about 92 per cent of the plus-2-in. ore will be waste and go directly to the dump.

The installation will be so flexible, according to C. N. Anderson, superintendent of the mill, that ores from the crusher pit can be carried directly to the 1,000-ton mill hopper without passing over the picking belts, if it seems necessary to do this.

Fund for Alaskan Prospectors Is Being Used

A bill to help the Alaskan prospector, passed last year by the territorial legislature, is being used to advantage. Applications have been received for more than half of the grant of $20,000, and it is likely that the balance will be under appropriation by the time the estimates for the coming year have been made. The fund is administered by B. D. Stewart, federal mining engineer for Alaska. In all, 70 applications have been received for grants.

Applications for placer prospecting exceed those for lode mining. Several applicants use airplane transportation, notably those going from Fairbanks into the Noatak and Kobuc rivers and their tributaries.

Companies Co-operate in Research Investigations

TO DETERMINE the power efficiencies of rod and ball mills and to arrive at an estimate of useless grinding done, U. S. Smelting, Refining & Mining, through a co-operative agreement with the Intermountain Station of the U. S. Bureau of Mines at Salt Lake City, is having a study made of grinding operations at the company's Midvale plant. Alan Probert, metallurgist at the U. S. S. R. & M. Sunnyside property, is engaged with the Bureau's technicians on the work.

Of primary consideration in the study is an investigation of the minus-200-mesh material, and, in this connection, it was necessary to devise a method and apparatus for elutriation. After the equipment was designed, it was standardized and calibrated for the various constituents of the ore under consideration. A number of tests were then made that conclusively indicated the distribution of the minerals in the various sizes of the minus-200-mesh material throughout the entire flow sheet of the company's plant. With this information available, it is believed that considerable knowledge may be gained concerning the recovery of fine mineral now being lost.

Operations Are Resumed at Many Southern Alaska Mines

VALDEZ and Anchorage are the centers of considerable mining activity as the coming of summer permits the development or reopening of many mines in southern Alaska. The Four-in-One Mining Company has been organized in New York to finance the development of the Red Cross Mountain copper property, on Miner's River, 7 miles inland from Unakwik Bay, Prince William Sound. The ore also contains some silver. C. Harper has purchased the holdings of the old St. Louis Mining & Trading Company at Turnagain Arm, 4 miles above Hope, and proposes operating the hydraulic plant this summer.

Supplies are being sent from Anchorage to the Quigley gold-quartz property at Kantishna, which is to undergo active development. The mine is 90 miles from the Alaska Government Railway. Monarch Mining has been organized at Anchorage to develop a mine on Crow Creek, Kenai Peninsula. About 1,000 ft. of development has been done on the property.

Alaska Hills Mines is resuming operations at its property on Nuka Bay. Activities at this property began in 1923, and a mill was erected in 1924 with a capacity of 40 tons. Total production from the mine to date is about $60,000. Other gold deposits at Nuka Bay are attracting increased attention. R. L. Hatcher and P. J. Nickoloff have purchased the Blair property, on which a vein is said to outcrop for a length of 1,500 ft.

A group of eighteen miners with a diamond-drill crew has gone into the Nebesna country to prospect a group of eighteen copper claims under the direction of D. C. Sargent. If results are as expected, it is proposed to secure transportation by extension of the Copper River Railway into the new camp. Alaska Gold Consolidated has been organized to take over and operate a hydraulic plant on holdings on Chicken Creek at Forty-Mile.

Federal M. & S. Options Mohawk, Near Smithers, B. C.

FEDERAL M. & S. has taken a two-year option on a controlling interest of Mohawk Mining and has undertaken to develop the company's property, situated on Four-Mile Mountain, near Smithers, B. C. A vein of silver-lead ore has been traced for a considerable distance on the surface and has been opened at depth by a tunnel. If the development proves an orebody sufficiently large to justify the move, Federal has undertaken to build a mill.

The Western Exploration Company has purchased the old Standard mine, in the Slocan district. The Standard made a net operating profit of more than $3,000,000 for its owner, Standard Silver-Lead Mining, up to 1918, when it was turned over to lessees as being worked out. R. A. Grimes, manager of Western Exploration, states that although he believes some orebodies remain in the Standard, it was purchased primarily for the water power and mill site. Western Exploration is developing the Mammoth, adjoining the Standard, and believed to be on the same shear zone. Three tunnels have encountered mineralization, and a fourth tunnel has been started. If development on the fourth tunnel proves satisfactory, a mill will be erected on the site of the old Standard mill and the tramway will be extended to the Mammoth. In the meantime the Standard flume and power plant is being repaired and the air-pipe line is being extended to the Mammoth.

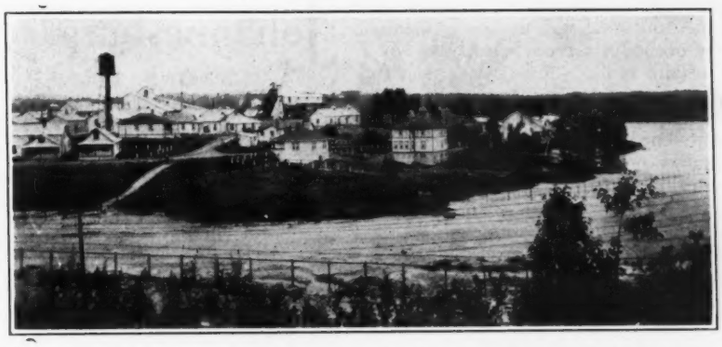
Jualin Mine, Near Juneau, Will Be Reopened

RESUMPTION of operations at the property of the Jualin Company, a Belgian organization, is planned this summer. The property is on Berner's Bay, near Juneau, Alaska. Work was suspended by the company during the war. In 1920 the mill was destroyed by fire.

The property comprises 30 claims. It is equipped with a tramway 5½ miles in length, a 450-hp. compressor, four semi-Diesel engines of 50 hp. each, and a hydro-electric plant. A drainage tunnel was being driven when work was suspended. This tunnel will have an estimated length of 7,800 ft. and has been completed for 4,000 ft. Jean Vanophem is the general manager.

State Geologist Urges Use of North Carolina Cyanite

H. J. Bryson, state geologist of North Carolina, believes that the cyanite deposits of the state will soon be extensively developed. Mr. Bryson recently completed a tour through the pottery-producing districts of Ohio, West Virginia, and Pennsylvania. He says that if the price of cyanite could be brought down to $30 a ton, all the manufacturers of pottery would use it.



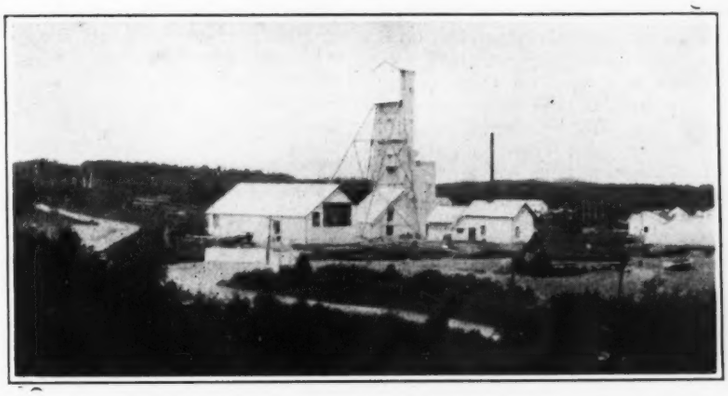
Teck-Hughes, Canada's second largest gold-producing mine

Teck-Hughes May Add 300-Ton Unit to Mill

TECK-HUGHES Gold, Kirkland Lake's largest gold producer at present, is considering the addition of a 300-ton milling unit, which would bring the capacity of its plant up to 1,150 tons a day—the largest tonnage in Ontario except for Hollinger. At its current output, the mine is producing about $1,300,000 of gold every quarter, compared with approximately $500,000 during the corresponding period in 1927. The decision on the new mill will depend largely on the showing made by the six levels recently opened. It is reported that a large new orebody has been discovered paralleling the main orebody. Workings are now down to 2,300 ft.

At the Lake Shore, in the same district, more than 1,000 ft. of ore is reported to have been developed on the 1,600 level. The vein varies from 7 to 9 ft. in width. On the 1,400 level, the same vein has been opened up for 500 ft. In June the new shaft will be completed to a depth of 1,000 ft. with the hoisting equipment recently purchased from the McIntyre, which is now being installed. By the end of June it is believed that developments will be sufficiently advanced to permit increasing the mill capacity to 1,000 tons a day.

Recent developments at Howey Gold, in the Red Lake district, have proved the existence of some of the high-grade ore which the management has been expecting for some time. On the 500 level a crosscut has shown a width of 9 ft. in the vein. Above that level, the grade of the ore is lower, but the widths are about the same. The levels are being maintained 125 ft. apart.



The new shaft of the Teck-Hughes mine

Errington Mine to Ship Concentrates to Idaho Soon

OPERATION of the new concentrator at the Errington mine of Treadwell Yukon, located in the Sudbury district of Ontario, has been started. As soon as it is in steady production a carload of zinc concentrates will be shipped to the new electrolytic zinc plant of Sullivan Mining at Kellogg, Idaho, which is expected to start operating within a few weeks.

At No. 1 shaft on the 300 level shrinkage stopes are being opened, and ore is being sent to the mill. Preparations are being made for production from the 500 level. A connection has been made with the No. 2 shaft on the 300 level. A crosscut is being driven at the 500 level of the No. 2 toward a known orebody.

Machinery and equipment are being gathered for the sinking of No. 3 shaft at a spot about two miles from No. 1. The orebody which will be developed by crosscuts from this shaft is said to be the best and highest in grade of any so far disclosed. To date operations have been hampered by mud and frozen roads, but the coming of summer will of course remove these obstacles.

Justice Godson Finds Lack of Co-ordination Caused Hollinger Disaster

Justice T. E. Godson, the commissioner of the Royal Commission appointed to inquire into the Hollinger mine disaster of Feb. 10, in which 39 lives were lost, has presented his report. Lack of co-ordination in the organization of the Hollinger company resulted in the disjointed system of control which permitted the dumping of thaw-house refuse in empty stopes, he finds. It was in one of these stopes, on the No. 5 level, that the fire broke out. A complete summary of Justice Godson's report will appear in the June 9 issue of *Engineering and Mining Journal*.

Three Kings Mining Company Makes First Shipment

The first car of ore from the property of the Three Kings Mining Company, situated in the Park City district of Utah, was shipped last week to the Midvale smelter of the U. S. Smelting, Refining & Mining Company. Settlement for the shipment was made on the basis of 20.4 oz. of silver a ton and 21.7 per cent lead. The property adjoins that of the Silver King Coalition Mines Company, and is a new development in the district.

Carson Hill Property Sold

The Carson Hill property, operated by Carson Hill Gold Mining at Melones, Calif., was sold at San Andreas, Calif., at a sheriff's sale on May 15, for $147,000 to David Fife, of San Francisco. Carson Hill shut down late in 1926 and an attempt was made to reorganize upon a plan which involved a number of dormant Mother Lode properties, a central milling plant, and the reopening of several mines, but this did not receive financial support, and failed. The present sale seems to be a move to protect the interests involved.

Report New Discovery at Old Dominion

A new vein of copper ore has been discovered on the 2,600 level of the Old Dominion mine, at Globe, Ariz. Though not a high-grade strike or of very great size, the find is encouraging because the vein is not one that has been found on the other levels. It runs parallel to the famous Old Dominion vein at a distance of 700 ft. The new vein is composed of quartzite and diabase containing several seams of chalcopyrite about 1 in. thick. Samples across the face of the drift average about 3 per cent copper. The new vein was encountered in a drift which was being driven to intersect the Old Dominion vein. The drift is encountering a great deal of water, and the temperature is about 110 deg. F., so that progress is rather slow.

Mexico City Letter

By W. L. Vail
Special Correspondent

Fire at Dos Estrellas Mines Causes Laying Off of About 3,000 Men

Mexico City, May 19, 1928.—The recent fire in the No. 5 level of the Dos Estrellas mines, near El Oro, State of Mexico, has caused a complete, but it is hoped temporary, suspension of work, and about 3,000 men have been thrown out of work. Dos Estrellas is a silver-gold property with a daily output of about 2,000 tons. The Cedro mill, in the same district, was also closed on account of lack of water, but the management is attempting to obtain a supply from the tanks of the International, enabling a resumption of activities. The fire was confined to the No. 5 level, but the presence of carbonic gas in the other levels caused all work to be suspended.

El Fuerte Mining Corporation, under a Delaware charter, proposes to merge the El Fuerte Mining & Smelting, Choix Consolidated Mining, and Los Platanos Mining companies. All the stock is owned by El Fuerte Mining. The consolidation controls 19 mine properties in the states of Sinaloa and Chihuahua. Considerable development work has already been done on most of the properties. The mines carry silver, gold, and copper ores.

A REPORT has been received from Jalisco to the effect that the Magistral Ameca Copper Company has recently resumed operations at its property near Ameca. The company owns 185 acres of ground on the Hacienda Hegira, 8 miles southwest of Ameca. Prior to closing, the claims had been developed by a shaft sunk 321 ft. and tunnels totaling 5,000 ft. in length. There is a 125-ton concentrator on the property.

According to rumor, the properties of the International Mining Company, situated 25 miles southeast of Zacatecas, are to resume operations. These properties were closed last September because of inability to treat ores and secure economical and proper recovery. The owners had expended more than $2,000,000 on the properties at the time of suspension, the disbursements including the cost of the construction of a railway extension from Zacatecas and of building a 600-ton mill to treat the silver-lead ore.

New properties are being opened up in the San Pedro district of Chihuahua, where large quantities of complex ores have recently been blocked out. Work is being carried on by El Paso (Tex.) interests. Carolina Silver Mines has begun development work on a group of five silver-lead claims, 12 miles east of Ahumada, Chihuahua. A dry concentrator is being constructed to treat the low-grade ores.

A number of men were recently laid off by Ahumada Lead, at Los Lamentos. A new orebody is reported on the No. 7 level of the mine. Some work is being done cleaning out a number of the upper stopes, but shipments are largely from development work.

Installation of a flotation plant to concentrate the dump and low-grade ores is planned by the Sindicato Minero Fundador Cerralvo-Bustamente at its properties near Agualeguas, Nuevo Leon.

London Letter

By W. A. Doman
Special Correspondent

John Howeson May Challenge Present Control of Tin Price

London, May 15, 1928.—John Howeson, as I have mentioned on previous occasions, is credited with the endeavor to create a monopoly, or obtain control, of the tin resources of the British Empire. Tin is an expensive commodity to carry or control. Hitherto, the price fixing of the metal has been done by one firm, which, knowing stocks in the different ports, quantities afloat, and the demand for spot and future amounts, so to say, has a monopoly in this respect. This monopoly will be challenged.

The people at the back of the Anglo-Oriental Corporation control a large proportion of both the Far Eastern and the Nigerian production through the London Tin Syndicate. At one time producers were largely dependent on the groups who owned the smelters, since they could not hold up their concentrates, because of the large sums involved. Now Anglo-Oriental, which is controlled by John Howeson, has acquired a large number of Australian-owned properties in addition to the holdings of its own companies, and also possesses a smelter of its own—the Penpol, at Liverpool. Being independent in that respect it hopes—so it is suggested to me—to challenge the present controllers of the price.

THE NITRATE world has become interesting again. Although Chile did not participate in the International Nitrogen Conference on the "Luetzow" in the Mediterranean, she was evidently informed of events. As a result the government has informed the Nitrate Producers' Association that if the prices of synthetic products are lowered during the coming season, it will return to Chilean producers, from their export duty payments, an amount per metric quintal equivalent to the reduction made by the synthetic producers. Any price cutting, therefore, will not affect the Chilean product adversely.

Consolidated Gold Fields is increasing its capital by the issue of 500,000 shares to buy new shares in the New Consolidated Gold Fields, which is taking up business in other directions.

Johannesburg Letter

By Owen Letcher
Special Correspondent

Transvaal Platinum Mines May Be Consolidated by Potgietersrust

Johannesburg, April 28, 1928.—An agreement is pending by which Eerstegeluk Platinum Mines, Ltd., the Schildpadnest Association, and Steelpoort Platinum Mines, Ltd., will sell all of their assets to Potgietersrust Platinums, Ltd. The considerations are as follows: To Eerstegeluk Platinum payment in cash of £37,500 and allotment of 1,150,000 fully paid 5s. shares of the purchaser company; to Schildpadnest the allotment of 300,000 fully paid 5s. shares of the purchaser company; and to Steelpoort Platinum the allotment of 400,000 fully paid 5s. shares. To provide for these payments, Potgietersrust proposes to increase the capital of the company to £1,962,500 by the creation of 1,850,000 new shares of 5s. each.

The directors of Potgietersrust have had this matter under consideration for some time and, in a circular to stockholders, have recommended the acquisition of the three properties on the advice of the consulting engineers. The present holdings of the company are extensive and include a number of valuable platiniferous deposits in the Potgietersrust district. An experimental plant is operating and more than 600 oz. of platinum-group metals are being recovered in concentrate form every month from 2,400 tons of ore crushed. The company also owns properties in the Rustenburg district.

THE EERSTEGELUK company owns the farms Kroondal and Klipfontein, in the Rustenburg district. More than 7,000 ft. of development work is estimated to have an average value of 5.3 dwt. of platinum-group metals per ton over a width of 36 in. It has been ascertained that 90 per cent of the value is contained in the lower 15 in. of the reef, which will permit a high milling grade to be maintained by narrow stoping.

Schildpadnest and Steelpoort have opened up a reef on the farm Schildpadnest, in the Rustenburg district, which has proved to be regular, with good values. A railway now under construction passes within a few miles of the property.

By this consolidation of interest it will be possible to undertake a comprehensive program of operations at a decreased cost, confined to proved areas, and to construct a reduction plant at an early date. Experiments in connection with the metallurgy of platinum are now in progress in Johannesburg, England, Germany and America. F. L. Bosqui and his son are said to have met with highly encouraging results.

Surface workings at the B. & B. quicksilver mines

B. & B. Quick Company Installing 50-Ton Furnace Plant

WORK is well under way on the installation of a 50-ton quicksilver furnace and accessory equipment at the property of the B. & B. Quick Company in the Fish Lake Valley district, west of Tonopah, Nev. This property has been operated for nearly a year on a small scale and has produced about 300 flasks of quicksilver from small "D" retorts in that time.

In 1926 the property was under a $75,000 option to the Tonopah Mining Company, which spent some money in development work before permitting the option to expire, subsequently attempting to secure a new option at a lower purchase price.

Officers of the company are Peter Buol, of Los Angeles, president, and E. P. Thomas, of Bakersfield, Calif., secretary-treasurer. Company headquarters are in Bakersfield. The company is incorporated under the laws of Nevada, for 200,000 shares of $1 par value. It is completely financed from within the organization and no stock is for sale on the open market. The property is situated on the northeastern slope of Mount Montgomery, in the White Mountain range, at an elevation of 8,000 ft. A 10-mile mountain road has recently been completed, giving the mine direct connection with Basalt, Nev., a station on the narrow-gage branch line of the Southern Pacific between Lone Pine, Calif., and Mina, Nev. This road was completed in April and reduces the distance between mine and railroad from 33 to 14 miles. Equipment for the new furnace plant is going in over this road, and it is expected that the furnace will be ready for operation some time in July.

This property has been examined and reported on by several reputable engineers. John M. Fox, consulting mining engineer of Johannesburg, Calif., made a comprehensive examination early in January of this year. According to the report of Mr. Fox, systematic sampling of the various mine openings indicated the presence of over 100,000 tons of ore, averaging 8 lb. of mercury per ton. Operating costs were estimated at $4 per ton of ore, or $40 to $50 per 76-lb. flask of quicksilver, allowing for metallurgical losses. Walter J. Childers is general superintendent in charge of operations. A considerable tonnage of high-grade ore has recently been added to the ore reserves as the result of a strike made in excavating for the furnace foundations. This ore occurrence is a considerable distance below what had previously been considered as the limits of the orebody.

A number of smaller properties in this district are receiving attention from outside interests as a result of the B. & B. activity.

Portal of Koble tunnel, main working level at the B. & B.

Construction of Dickens Mill Is Started

WORK on the new 200-ton flotation mill of Dickens Consolidated Mining at Wallace, Idaho, has been started. Construction is under the supervision of W. L. Zeigler, superintendent of the Hecla Mining mill, who also prepared the plans for the new concentrator. At the mine it has been decided to sink the shaft 200 ft. from its present depth of 400 ft. Enough ore is blocked out to provide for several months' run of the mill, which should be completed by August. Special interest attaches to the successful development of the Dickens mine because of its location in the Moon Creek section of the Coeur d'Alene district. Moon Creek is classified geologically as Prichard slate. However, the shaft seems to have passed through the Prichard and entered the Revett quartzite formation, which is the formation in which most of the lead deposits of the district have been found.

At the Morning mine of Federal M. & S., the shaft has been deepened 200 ft. A crosscut to the orebody from the new bottom level of the mine has shown better grade and greater width than on any level above. The ore is 16 ft. wide and contains commercial quantities of silver, lead and zinc. Preparations are being made for an additional 200 ft. of shaft sinking in the hope that the orebody will prove as extensive as on the three levels above.

Production has been started at the Lookout Mountain mine, on Pine Creek in the Coeur d'Alene district. The mill, which was recently acquired from Amy-Matchless, started to handle the silver-lead ore from the mine on May 21. To facilitate transportation from mine to mill, a 1,600-ft. tramway was built and two large ore bins were constructed. The stopes are open for more than 200 ft.

Development Work Continues at Highland Property

DEVELOPMENT work at the Highland property of Ardsley Butte, in the Butte district of Montana, continues to form the major part of the company's program. Over 60 per cent of the work being done is in development. In a winze on the Highland vein, about 50 ft. below the 350 level, it is reported that high-grade ore has been encountered. When the winze reaches the 410 level, the vein will be crosscut, to see if it shows continuation of the widths on the upper levels.

In the first four months of the year, Ardsley Butte shipped approximately 9,850 tons from the property, for which mill returns were $121,500.

Argenta Mining, operating on 200 acres of ground near Argenta, Beaverhead County, Mont., is planning to ship its ore to Germany for treatment. The ore is bismuth-gold.

Societies, Addresses, Reports

M. & M. Society Hears How Big Mines Are Financed

"METHODS of Financing Large Mining Operations" was the subject of a special meeting of the Mining and Metallurgical Society of America at the Harvard Club, New York City, on Wednesday, May 23. The principal address was given by H. B. Fernald, of Loomis, Suffern & Fernald, who discussed some of the fundamental aspects of the matter. He amused his audience by his introduction, wherein he mentioned a common method of financing and development of a mining property in which the first step was to decide how many shares of stock should be issued and how much the public would pay for them; second, to try to develop the property so that its value and productive capacity would be in fair relation to the stock issued; and third, to hold the operating staff to strict account for living up to what is expected of them. Space forbids even an abstract of Mr. Fernald's concise remarks, the nature of the subject being such that too much condensation is not possible.

C. H. Crane, president of the St. Joseph Lead Company, presided, and called on Messrs. Smith, Mayer, Moulton, Prentiss, Brownell, and Burleigh to contribute to the discussion, which they did with more than usual success. Both DeWitt Smith and H. G. Moulton discussed methods used by various companies in recent years, showing their diversity as affected by varying conditions. Mr. Moulton emphasized the change in the public attitude toward large financing, affirming that an operation that was properly certified by responsible people had only to put its securities on the market to have them taken up, contrasting strongly with conditions some years ago. Mr. Brownell developed this point further, stating that the large mining companies were combing the world for desirable properties, and that once they were found, ample money was available for their development. He divulged the fact that the American Smelting & Refining Company made a strenuous effort to get a chance to bid on Mount Isa, the promising big lead-silver-zinc property in Australia, but that arrangements were consummated with Russo-Asiatic, in London, before an A. S. & R. official had a chance to get over there.

Engineering Foundation Seeks to Increase Endowment

THE endowment committee for Engineering Foundation and Engineering Societies Library, to which Herbert Hoover, Secretary of Commerce, was recently appointed by the United Engineering Society, has announced its intention of securing a fund of five million dollars to expand its program better to meet the needs of industry.

Engineering Foundation, an organization to aid advances in the use of the sciences, was organized about thirteen years ago on the basis of a generous gift from Ambrose Swasey, of Cleveland, Ohio. This has been supplemented by large gifts from Henry R. Towne, Edward Dean Adams, and others. The income has been used to promote research, largely under the direction of the four great engineering societies.

Engineering Foundation has not been unmindful of the human elements in modern engineering and industry. It helped establish the Personnel Research Federation, which is bringing about cooperation among numerous organizations that study the many problems affecting men and women at work in industry, business, education, and in governmental departments. The foundation is also aiding the Society for the Promotion of Engineering Education in its endeavors to improve the methods of teaching, the selection of students, and the adaptation of education to the needs of industry and the professions.

Mines Faculty Enlarged at University of Utah

COINCIDENT with commencement at the University of Utah next week, the following new appointments, effective July 1, to the faculty of the department of mining and metallurgical research will be announced:

Walter E. Keck, assistant professor of metallurgical research.

Arthur L. Crawford, assistant microscopist.

Mr. Keck is a 1927 graduate of the Michigan College of Mines. Last year he held a fellowship at the University of Arizona, where he engaged in research work with the staff of the Southwest Experiment Station of the U. S. Bureau of Mines. Mr. Crawford graduated with the degree of bachelor of arts from Brigham Young University in 1924, and in 1925 received his master of arts degree from Stanford University. During 1926-27 he was an instructor in mineralogy, petrography, and economic geology at Brigham Young University.

Utah Section of A.I.M.E. Holds Annual Meeting

The annual meeting of the Utah section of the A.I.M.E. was held on May 19 at the Newhouse Hotel, Salt Lake City. Addresses were made by George Otis Smith, president, and H. Foster Bain, secretary, of the Institute. Officers elected for the coming year of 1928-29 were J. M. Boutwell, chairman; J. A. Norden, vice-chairman; and C. T. Van Winkle, secretary.

Institute of Metals Accepts A.I.M.E. Invitation to Co-operative Meeting

AT A GENERAL meeting of members of the Institute of Metals, held in London on May 8, an invitation was presented by W. M. Corse, honorary corresponding member for the United States, to the meeting, on behalf of the A.I.M.E. It was written by George Otis Smith, president of the A.I.M.E., and invited the Institute to a joint meeting in the United States in 1932. The president of the Institute of Metals, Dr. W. Rosenhahn, in acknowledging the invitation indicated that it would be gladly accepted by the Institute.

A good attendance of members at the proposed meeting is expected, as the ample notice of the date will enable many persons to make the necessary arrangements who could not do so were such a trip arranged at short notice.

University of Utah Awards Five Fellowships

FROM a list of sixteen applicants for fellowships in the department of mining and metallurgical research at the University of Utah, the following five additional appointments for the year 1928-29 are announced by the authorities of that institution:

Ralph R. Hultgren, B. S., University of California.

John T. Eash, B. S., Purdue University.

Clyde H. Wilson, B. S., University of California.

Alex M. Gow, Graduate, University of Minnesota.

J. D. Forrester, B. S., University of Utah.

Mr. Hultgren graduated with highest honors in the 1928 class of the University of California, and is the recipient of the university medal of that institution. Mr. Wilson, also, graduates with honors this year from the same university, and has been the holder of an A.I.M.E. auxiliary fellowship there for the last four years. Mr. Gow is a 1923 graduate of the University of Minnesota, where for one year he was engaged in graduate work at the school of mines experiment station, later serving as instructor in mining. Mr. Forrester is graduating in geological engineering at the University of Utah, and as a fellowship holder will be engaged in microscopic research work under the direction of R. E. Head, microscopist of the Intermountain Station of the U. S. Bureau of Mines.

Missouri School of Mines Holds Commencement

At the commencement of the School of Mines and Metallurgy, University of Missouri, on May 24, 1928, a total of 72 men were graduated. Of these 19 men were students of metal mine engineering.

Book Reviews

Cripple Creek's Gold

YELLOW GOLD OF CRIPPLE CREEK. By Harry J. Newton. Houghton Publishing Company, 1848 South St., Denver. Price, paper, $1; cloth, $1.50.

THE author is evidently of the opinion that a little publicity will do Cripple Creek no harm. Inasmuch as the book is copyrighted by the Cripple Creek Mines Bureau, Inc., apparently others have the same view. As a matter of fact, it is surprising that so little is heard of Cripple Creek nowadays, for it is still producing an important quantity of gold. The book contains 128 pages $5\frac{1}{4}$x$7\frac{1}{2}$ in. in size and more than 100 illustrations. It is devoted to romances and anecdotes of the early days of this famous camp.

PROTECTIVE METALLIC COATINGS. By Henry S. Rawdon. Chemical Catalog Company, 419 Fourth Ave., New York. Pages 278. Price $5.50.

THIS BOOK is one of the American Chemical Society's series of scientific and technologic monographs on chemical subjects. It is intended to present in readable form the knowledge available on the subject selected; also to promote research in it, by summarizing the progress already made and by pointing out where further studies may profitably be made.

Protective metal coatings have in corrosion their principal reason for existence. Dr. Rawdon has corrosion in mind throughout the book. The term "protection" may be construed to mean "protection of iron and steel," since it is in iron and steel that the greatest part of corrosion loss occurs. Aside from the introductory chapter, the book is divided into four parts under the following headings: Coating Methods (four chapters, including dipping, electroplating, and spraying); Commercial Metallic Coatings (seven chapters, covering zinc, copper, nickel, chromium, cobalt, lead, cadmium, aluminum, gold and silver, and miscellaneous); Testing Methods; and, fourth, a comprehensive bibliography. The book is technical, yet not to such an extent as to rob it of its practical value to the non-technical man in industry.

BERG - WIRTSCHAFTLICHE ARBEITSGEMEINSCHAF — EINE PROGRAMMSCHRIFT. By Max Krahmann. Kurt Vowinckel, publisher. Berlin-Grunewald. Pages 184. Price, 10 marks.

PROFESSOR KRAHMANN proposes to establish a "free" association for the consideration of mining economics, with the ultimate purpose of establishing an International Institute of Mining Economics. He includes an invitation to co-operate, written in three languages. The subject of mining economics has been almost wholly disregarded, he says, at the various congresses convened to study economic problems. In considering the relations that obtain between "The State and Economics," Professor Krahmann observes, agricultural interests have always been given preference. In this book he sets forth his views on the subject. In an appendix, he adds various documents from his correspondence and also from the proceedings of the League of Nations, the latter papers also being presented in German, French, and English.

ELECTRIC CONTROL GEAR AND INDUSTRIAL ELECTRIFICATION. By William Wilson. Oxford University Press, London. American Branch, 35 West 32nd St., New York. Pages 362. Price $8.50.

THE MODERN trend toward electrification of industry should make this book of interest to others than electrical engineers. Naturally, British practice is dwelt upon. If American engineers object to this, they should bear in mind that British apparatus is being introduced in the United States in many instances, and that even now an important manufacturer is making a type of switchgear long used abroad but entirely new to this country. The book is primarily concerned with the design, arrangement, and construction of electric control apparatus. It contains 23 chapters, each devoted to some particular class of equipment. Each chapter, the author states, has been made complete in itself, as far as possible, and capable of being read and understood independently of the rest. He has pursued this policy to enhance the value of the book for reference purposes. Among the topics treated are: Direct Current Motors; Alternating Current Motors; Manual Starters and Controllers; Resistance Control; Multiple-Voltage and Series-Parallel Control; Solid Resistors; Liquid Rheostats; Contactors; Electric Braking; Motor-Generator Control Systems; Control of Furnace and Mine Hoists and Underground Control Gear; Electric Cranes and Gantries; and Machine Tool Control. The book contains 200 illustrations.

THEORY OF CONTINENTAL DRIFT. A symposium. Published by American Association of Petroleum Geologists, Box 1852, Tulsa, Okla. Pages 240. Price $3.50.

"THEORY of Continental Drift" is a symposium by international authorities on the origin and movement of land masses, both inter-continental and intra-continental. Fourteen papers compose the book. The authors are representative practical petroleum geologists and prominent members of college and university faculties. The symposium was arranged under the leadership of Dr. W. A. J. M. van der Gracht, who presented the leading paper, followed by discussions by the other authors, at a meeting of the American Association of Petroleum Geologists held in New York City. The contributors to the discussion are: Bailey Willis, of Leland Stanford; R. T. Chamberlin, of Chicago; John Joly, of Dublin; G. A. F. Molengraaff, of Delft; J. T. Gregory, of Glasgow; Alfred Wegener, of Graz; Charles Schuchert and C. R. Longwell, of Yale; F. B. Taylor, of Fort Wayne; William Bowie and David White, of Washington; J. T. Singewald, Jr., and E. W. Berry, of Johns Hopkins. A prefatory note has been written by E. De Golyer, president of the Amerada Petroleum Corporation, New York. The book contains 29 illustrations and a valuable index.

IRON ORE, SOUTH AFRICA—"The Iron Deposits of the Union of South Africa" is the title of the Memoir No. 26 of the Geological Survey of the Union. This 268-page volume may be obtained from the Government Printing and Stationery Office at Pretoria, at 10s. per copy. The author is Percy A. Wagner. In conclusion Mr. Wagner says that a comparison of the estimated iron-ore resources of the Union with those of other countries shows that, even if the titaniferous ores, of which she possesses the greatest known deposits, be excluded, the reserves of the Union are apparently exceeded only by those of India, the United States, Brazil, and France. Inasmuch as the Union also has great resources of coking coal, manganese and other ferro-alloy ores, limestone, dolomite, fluorspar, and refractories, he concludes, there can be no question that the production of iron and steel is destined to be a factor of the greatest importance in its economic development.

ALLUVIAL DEPOSITS—The April *Bulletin* of the Institution of Mining and Metallurgy contains an article by W. R. Rumbold on "The Valuation of Alluvial Deposits." The author hopes that discussion of his observations may lead to a helpful definition of various classes of alluvial ore reserves. He proposes that no alluvial deposit should be considered "proved" unless a minimum number of sample holes have been sunk on it, and suggests the boring of four holes per acre. He also suggests that the expression "probable ore reserves" should be abolished, and if the words "partly proved" be used in a report, the number of sample holes per acre be stated. He also asserts that cubic yardage and assay values of the different sections of the mine should always accompany figures of concentrate tonnage, and that the price of the metal upon which calculations of profit are based should likewise be stated.

GEOPHYSICS — The *Canadian Mining and Metallurgical Bulletin* for May devotes 95 pages to a series of papers on geophysical methods of prospecting. These papers were presented at the annual general meeting of the Institute at Quebec in March. In this symposium are included the following: "The Electromagnetic Method," by Etienne S. Bieler, assistant professor of physics, McGill University; "The Radiore Proc-

ess," by E. H. Guilford, chief engineer of the Radiore Company; "The Present Status of Geophysical Methods of Prospecting," by Hans Lundberg, of the Swedish American Prospecting Company of Canada; and "Some Applications of Potential Methods to Structural Studies," by E. G. Leonardon and Sherwin F. Kelly. The first two papers brought forth an extended discussion.

DUMORTIERITE — The University of Nevada has issued a bulletin (Vol. 22, No. 2, March 15, 1928) on the mineral dumortierite. This has been prepared by the staff of the Mackay School of Mines. The mineral is known to occur at four places in Nevada. It was recently referred to in a bulletin of the American Refractories Institute as being one of the refractories now in process of development. At present, it is being produced at only one mine in the United States—namely, that of the Champion Porcelain Company, near Oceana, Nev. The mineral is a silicate of aluminum of less common occurrence than andalusite and sillimanite. It differs from these minerals in that, besides the elements aluminum and silicon, it also contains a small percentage of boron.

CONTINENTAL DRIFT — Those interested in the hypothesis of continental drift will want to add to their libraries the paper entitled "Some Reflections Upon a Geological Comparison of South Africa With South America," which was read on March 19 by A. L. Du Toit before the Geological Society of South Africa, of which he is president. The paper is being reprinted by the *South African Mining and Engineering Journal*, beginning with the issue of March 24. Dr. Du Toit's address comes on the heels of the recent symposium on the subject of continental drift which was held under the auspices of the American Association of Petroleum Geologists and which is mentioned on p. 913. It is a welcome addition to the papers included in that group.

MINING LAW, IOWA—A pamphlet containing the text of the revised law of Iowa relating to the inspection and regulation of mines and mining, reprinted from the Code of 1924, has been received from W. E. Holland, state mine inspector, Centerville, Iowa. Most of the regulations refer to the operation of coal mines. A separate chapter, however, is devoted to gypsum mines.

The same mail brings a bound copy of Vol. XXXII of the Iowa Geological Survey. This contains the annual reports of the state geologist for 1925 and 1926, with certain accompanying papers. The book contains 550 pages and is bound in cloth.

SPEISS, PLATINUM GROUP—H. Rusden and J. Henderson discuss the subject of speiss and the metals of the platinum group in a 15-page article in the February issue of the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa. The authors state that although the results of their work were largely negative, much useful information was obtained for future research on this interesting material.

UPPER SILESIA ZINC—A paper, written in German and entitled "The Upper Silesian Zinc Ore Deposits—The Tectonics of the Bottom Strata in Their Relation to the Ore Occurrence of the Beuthen Syncline"—has been issued by the *Zeitschrift des Oberschlesischen Berg-und Hüttenmännischen Vereins*, Katowice, Silesia. The author is Kurt Seidl. The price unbound is 15 marks. The paper contains 38 pages of large size and well illustrated.

POWER PRODUCTION—The total capacity of power-generating equipment sold in the United States in 1923, exclusive of horsepower of pleasure automobiles, was 230,514,000 hp., according to Water Supply Paper 559 of the U. S. Geological Survey. This information and other interesting data are given in a report entitled "Power Capacity and Production in the United States." The report comprises 200 illustrated pages.

HYDROGEN ION CONTROL—Useful information on this timely subject is contained in a bulletin entitled "The A B C of Hydrogen Ion Control," issued by Lamotte Chemical Products Company, of Baltimore. An excellent description of the use of hydrogen ion indicators and their application in various industries is included. Flotation operators might use these indicators to advantage.

GEOLOGY OF GAMBIA—Bulletin No. 3 of the Gold Coast Geological Survey, just received, is entitled "A Report on a Rapid Geological Survey of the Gambia, British West Africa." The author is W. G. E. Cooper, of the Survey. The appendix contains a report on the marine mollusca and other remains from near Barra Point, Gambia, by A. Morley Davies.

POTOSI, GEOLOGY—*Economic Geology* for May contains a 30-page article by Waldemar Lindgren and J. G. Creveling on "The Ores of Potosi, Bolivia." The deposits of this famous silver-tin district are discussed. Though credited with a production of 30,000 tons of silver since its discovery in 1545, Potosi is yielding but a small output at present.

GEOLOGY, IDAHO—The Idaho Bureau of Mines and Geology has issued a bulletin (Pamphlet No. 26) entitled "Geology and Ore Deposits of the Rocky Bar Quadrangle," by S. M. Ballard. The bulletin is in multigraphed form, and comprises 41 pages and two geologic maps. The quadrangle is in Elmore County.

NORTH CAROLINA GEOLOGY—Herman J. Bryson, state geologist of North Carolina, has issued a 63-page pamphlet (Economic Paper No. 62) entitled "The Mining Industry of North Carolina During 1926." It may be obtained from the State Department of Conservation and Development at Raleigh, N. C.

C.I.M.M. TRANSACTIONS—Vol. XXX of the *Transactions* of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia is ready. It includes the papers issued by the societies during the year 1927.

MANGANESE—The address of J. Carson Adkerson, president of the American Manganese Producers' Association, made at the opening of the nodulizing plant of the Domestic Manganese & Development Company at Butte, Mont., on March 17, has been issued in pamphlet form and is available for distribution.

MINING, IDAHO—Stewart Campbell, State Inspector of Mines for Idaho, has issued the twenty-ninth annual report on the mining industry in that state. It covers the year 1927. This bulletin of 280 pages is one of the most complete reports of its kind. It makes an excellent reference book for those interested in mining in Idaho.

WESTERN AUSTRALIA—A copy of the 1928 edition of the "Pocket Yearbook of Western Australia" has been received from the secretary's office at Perth. It is 3½x4 in. in dimensions and about one-quarter of an inch thick. It contains statistics of a miscellaneous sort.

IRON ORE—The familiar little bulletin entitled "Analyses, Lake Superior Iron Ores," which is issued annually by the Lake Superior Iron Ore Association, Union Trust Building, Cleveland, Ohio, has made its appearance. It covers the season 1927.

Government Publications

Several government publications have been received in the last two weeks. They are as follows:

"Experiments in Underground Communication Through Earth Strata," by L. C. Ilsley, H. B. Freeman, and D. H. Zellers. Bureau of Mines Technical Paper No. 433. Price 20 cents.*

"Rock Strata Gases in the Cripple Creek District and Their Effect on Mining," by E. H. Denny, K. L. Marshall, and A. C. Fieldner. Bureau of Mines paper. Serial No. 2865. Twenty-four pages.

"The Iron Industry in 1927." A five-page press bulletin issued under date of May 5, 1928, by the Department of Commerce. It describes the condition of the iron industry in the past year.

"Titanium in Bauxite Ores and Sludges." Bureau of Mines paper. Serial No. 2867. By Will H. Coghill. Four pages.

The following papers have been issued by the Geological Survey:

"Notes on Pleistocene Faunas From Maryland and Virginia and Pliocene and Pleistocene Faunas From North Carolina." By Wendall C. Mansfield. Professional Paper 150-F.

"The Pocono Fauna of the Broad Top Coal Field, Pennsylvania." By George H. Girty. Professional Paper 150-E.

"Sedimentary Rocks of the San Rafael Swell and Some Adjacent Areas in Eastern Utah." By James Gilluly and John B. Reeside, Jr. Professional Paper 150-D.

"Notes on Practical Water Analysis." By W. D. Collins. Water Supply Paper 596-H.

*Sold only by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

Personal Notes

JAMES S. DOUGLAS is expected in New York soon.

CHARLES A. MITKE has returned to Phoenix, Ariz., after a trip to London.

CHARLES JANIN, of San Francisco, has just returned from a professional trip to Europe.

D. F. JOHNSON is now with the Black Range Mining Corporation at Santa Rita, N. M.

ABBOT A. HANKS, of San Francisco, will leave in June on a three months' trip to Europe.

HOWARD D. SMITH, president of the Consolidated Coppermines Corporation, is in New York.

A. RINGGOLD BROUSSEAU has joined the engineering staff of Texas Gulf Sulphur at Boling, Tex.

ROLAND BLANCHARD, of Duncan, Ariz., has been in the East, visiting New York and Boston.

RICHARD S. DIXON is now with the Moctezuma Copper Company at its properties in Nacozari, Sonora, Mexico.

FRANK L. BOSQUI and wife sailed from Southampton for Cape Town on May 11 on their return to Johannesburg.

ARTHUR WINSLOW sailed from Liverpool for Boston on May 23 on his return from a two months' visit in London.

H. C. BELLINGER, vice-president of Anaconda Copper, returned to New York on May 28 from a trip of inspection in Chile.

H. L. BROWN, mining engineer for the American Metal Company in Denver, has gone to Matahambre, Cuba, for three weeks.

FREDERICK BURBIDGE, general manager of Federal Mining & Smelting, is visiting the company's properties in the Tri-State district.

CARL J. TRAUERMAN, of Butte, Mont., has been elected alternate from Montana to the Democratic National Convention at Houston.

B. F. PHILLIPSON, president of the Climax Molybdenum Company, left New York last week for a three months' trip in Europe.

E. P. LANNON, general manager of the U. S. Zinc Company, has transferred his headquarters from Sand Springs, Okla., to Amarillo, Tex.

G. C. RISER, superintendent of concentrator of the Nevada Consolidated Copper Company, McGill, Nev., arrived in Salt Lake City on May 21.

S. H. LORAIN, formerly on the engineering staff of the Chicagoff Development Company, has been appointed engineer for the Apex-El Nido mine.

C. H. MILES has been engaged as consulting engineer by the Thunder Bay Silver Mines, Ltd., operating the Rabbitt mine, in the Thunder Bay district of northern Ontario.

R. N. HUNT, chief geologist of the U. S. Smelting, Refining & Mining Company, is in the Quartz Mountain district of Nevada, making an examination of the mining properties there.

CORNELIUS F. KELLY was re-elected a member of the executive committee of the National Industrial Conference Board at the board's twelfth annual meeting held recently in New York City.

RUSSELL C. MCGINNIS has joined the Eagle-Picher Lead Company at its Chicago offices. Mr. McGinnis was formerly a member of the engineering section of the Income Tax Unit at Washington, D. C.

LEONART NORDENFELT, Swedish inventor of hollow drill steel, has been visiting the Western mining districts. Mr. Nordenfelt was awarded a scholarship in the Royal University of Technology at Stockholm.

MORONI HEINER, vice-president of the U. S. Fuel Company, of Salt Lake City, was elected a director of the East Standard Mining Company at a meeting of the last-named company held in Salt Lake City on May 25.

J. M. TIPPETT, superintendent of the Independence mill of Portland Gold Mining, has resigned and has accepted a position with the Chino Mines of Idaho Springs and Central City, Colo. He will supervise the construction of a concentrator.

GEORGE OTIS SMITH and H. FOSTER BAIN, president and secretary, respectively, of the A.I.M.E., are in California, where they attended the joint meeting of the Southern California and San Francisco sections of the Institute at Yosemite Valley on May 25-28.

R. O. JEHU, president and general manager of Utah Sulphur Industries, Sulphurdale, Utah, is on a trip in the interests of his company. He will return to Sulphurdale on June 20, after visits to Los Angeles, San Francisco, Salt Lake City, Chicago, and Detroit.

J. P. BONARDI, sales manager of the Mine & Smelter Supply Company, 42 Broadway, New York, left on June 1 for a month's business trip to his company's Denver branch and factories. Before returning, Mr. Bonardi will visit various metallurgical plants in the Southwest.

CHARLES M. RATH, of Denver, was elected president of the Colorado School of Mines Alumni association recently. Other officers are WARD BLACKBURN, vice-president; C. L. COLBURN, secretary; E. P. ARTHUR, treasurer; and WILLIAM KOCH, member of the executive committee.

G. A. JOSLIN is making examinations of mining properties near Nevada City and also in Siskiyou County, Calif. On his return to Los Angeles he will proceed to San Janvier, State of Sonora, Mexico, to start operations on the Santa Rosa mine, which he and associates of Los Angeles have under option.

Prof. KIRTLEY F. MATHER, head of the Harvard University department of geology, will lead a group of geology students on a tour of the Swiss Alps this summer. The party will be joined by a group from the University of Geneva, headed by Prof. L. W. COLLET, head of the geology department of that institution.

W. M. CORSE, consulting metallurgist, Washington, D. C., and secretary of the Institute of Metals division of the A.I.M.E., attended the meetings of the Institute of Metals of Great Britain in London recently. Mr. Corse visited France, England, Sweden, and Norway, and addressed the Society of Scientific and Industrial Research at Stockholm, Sweden, on the subject of industrial research in the United States.

E. A. HAMILTON, manager of mines, of U. S. Smelting, Refining & Mining, was stricken with appendicits on May 23 while inspecting the Park Bingham mine in Bingham Canyon, Utah, with D. D. MUIR, Jr., vice-president and general manager of the company, and A. B. MARQUAND, assistant to the general manager. Mr. Hamilton was rushed to the Bingham hospital, and operated on immediately. His condition is reported to be satisfactory.

M. N. SHAW, of Colorado Springs, has been engaged as mill superintendent by the Venus Silver Mines Company, operating the Deer Trail and Providence mines in the Deer Trail district, Stevens County, Wash. Mr. Shaw was formerly with Golden Cycle Mining & Milling Company, of Colorado Springs, Colo., being engaged in the company's 1,000-ton cyanide plant. He is a graduate of the Colorado School of Mines and prior to joining the staff of Golden Cycle was with the Tintic Standard in Utah.

OBITUARY

CYRUS L. TRIPP, formerly connected with the Standard Metal Company, died at Wheeling, W. Va., recently. Mr. Tripp was 73 years old.

ROBERT GREY, general manager of the Southern Metals Corporation, died suddenly at Lordsburg, N. M., May 19. He was 46 years old. Mr. Grey was a lawyer, and had been associated with some Eastern interests in the development of mines in the Lordsburg district.

J. M. DAVIDSON died at Seattle recently. He took a prominent part in securing the financial support of U. S. Smelting, Refining & Mining for the Fairbanks Exploration Company's enterprise at Fairbanks, for which three dredges have recently been sent to Alaska. Mr. Davidson was one of the organizers of the Miocene Ditch Company at Nome.

Market and Financial News

Organization of European Zinc Cartel Has Been Completed

ACCORDING to recent word from Europe, the meeting held on May 7, in Brussels, Belgium, resulted in the organization of what is to be known as the European Zinc Cartel, with headquarters at the Brussels office of the Vieille-Montagne Company, 23 Rue Belliard, Brussels. M. St. Paul de Sinçay, of that concern, is the first president of the cartel, the life of which is to be from May 1, to Oct. 1, 1928, when another meeting will be called to consider the continuance and expansion of membership of the newly formed organization.

The cartel is to function, at first, entirely as an agency for the compilation and distribution of statistics and, with the help of the information thus secured, to control production; no consideration is to be paid to price fixing. At the meeting on May 7, about 95 per cent of the European zinc production was represented. The exact membership of the cartel has not been announced, but the members are included in the following list of companies having representatives at the preliminary meeting:

Belgium — Vieille-Montagne Company, Union des Usines à Zinc; Holland—Zincs de la Campine; France—Asturienne, Montagne, Penarroya, Vieille-Montagne (French division); Germany—Zinc Smelters' Association; Poland—Oberschlesische Zinc, Giesche, Hohenlohe; England—Smelter representatives; Spain—Asturienne, Penarroya; Italy—Penarroya; Norway—Delegates present but connections unknown; United States—Officials of Anaconda Copper and of the American Metal Company attended, but in an unofficial capacity, according to reports.

American participation is not expected unless the legal position of the domestic producers should be changed by official interpretation of the existing laws in a more favorable light.

Members in the cartel cannot withdraw before Oct. 1, 1928; two months' notice must be given before the withdrawal of any member can be accepted.

STATISTICAL NOTES

TRANSVAAL METAL AND GEM PRODUCTION for 1926 and 1927 compare as follows:

	1927	1926
Gold, oz.	10,130,630	9,962,852
Silver, oz.	1,011,736	981,333
Diamonds, carats	3,097,832	1,698,534
Osmiridium, oz.	5,420	6,360
Platinum, oz.	10,431	4,951

CONSOLIDATED MINING & SMELTING COMPANY of Canada's production for the first quarter of 1928 compares with that for the first quarter of 1927 as follows:

	First Quarter	
	1928	1927
Gold, oz.	74,037	74,064
Silver, oz.	2,048,029	1,720,088
Lead, tons	42,060	34,153
Zinc, tons	22,089	16,020
Copper, tons	2,305	2,617

The company is planning to increase its zinc plant capacity from 275 to 375 tons per day. Byproduct cadmium is now being produced at the rate of nearly one ton per day.

TASMANIAN METAL AND MINERAL production for 1927 is reported as follows: Cadmium, tons, 19; copper, tons, 5,811; gold, oz., 4,861; lead, tons, 5,583; limestone, tons, 169,522; nickel, tons, 86; osmiridium, oz., 633; silver, oz., 741,782; shale, tons, 3,150; tin, tons, 1,106; wolfram, tons, 146; zinc, tons, 6,326.

TONOPAH BELMONT DEVELOPMENT COMPANY, operating the Belmont MacNeil mine, near Palo Verde, Maricopa County, Ariz., and the Tonopah Belmont mine at Tonopah, Nev., reports net income for 1927 of $14,868 before depreciation or depletion.

KEELEY SILVER MINES directors confirm the report that the company proposes to keep $1,000,000 intact in the treasury and to use the interest derived from investments and in capital surplus over and above this amount for exploratory purposes until such time as a property has been found with sufficient promise to justify large capital outlay in its development. As of March 1, 1928, current assets over liabilities amounted to $1,158,081. With the payment of the last dividend the company has disbursed to shareholders a total of $2,240,000. It is expected that dividends will be discontinued from this time on.

BOLIVIA'S TIN industry is depressed by the prevailing low prices for tin, according to information made public by the U. S. Department of Commerce. A few of the smaller mines are now said to be working at a loss, and others have either reduced the number of employees or have cut wages 10 per cent.

UNITED VERDE EXTENSION MINING COMPANY reports a net loss of $533,771 in 1927, which compares with a net profit of $250,314 in 1926. The company mined 244,912 tons of ore in 1927, assaying 8.38 per cent copper, 0.04 oz. gold, and 1.69 oz. silver. Cost of producing copper, before depreciation and taxes, was 7.22c. a pound. Ore reserves at end of the year were approximately 960,000 tons, assaying in excess of 8 per cent copper.

Copper-Mining Companies Show Big Gain in Profits

COPPER producers and automobile manufacturers lead in increased profits in the first quarter of 1928, compared with the same period a year ago, according to a compilation of the National Bank of Commerce. Each gained 28 per cent. Net income of 225 general business corporations for the first quarter of 1928 was $341,000,000, compared with $318,000,000 in the first quarter of 1927, which represents a gain of 7 per cent. The advance, however, is cut to 5 per cent when United States Steel and General Motors are excluded. Significant advances in the individual groups are:

Number of Companies	Group	Advance (Per Cent)
18	Motor	28
8	Copper	28
13	Chain stores	18
9	Chemical	7
15	Motor equipment	6
23	Food manufacturing and allied industries	4

Among the groups whose earnings declined in the first quarter of this year from the first quarter of 1927 were:

Number of Companies	Group	Decline (Per Cent)
22	Petroleum	43
5	Railway equipment	43
18	Iron and steel	20
11	Building materials	16

Earnings of 27 public utilities during the first quarter amounted to $88,000,000, compared with $77,000,000 last year, a gain of 14 per cent. Net operating income of 186 Class I railroads during the first quarter was $217,000,000, a decline of 4 per cent from the figure of $226,000,000 for the first quarter of 1927. The favorable position of the copper group indicates the effect of the higher price for copper.

MINING CORPORATION OF CANADA, LTD., produced 2,119,771 oz. of silver in 1927, a slight decrease from the 2,210,050 oz. production figure for 1926. Profits of $544,601 compare with $602,000 in 1926. Tonnage and production details are indicated in the following table.

	1927
Tons of mill-ore treated	52,235.00
Assay value, ounces of silver, per ton	28.01
Ounces silver contained	1,463,297.67
Ounces silver returned by Reduction Company	1,261,951.12
Percentage returned under contract	86.24

NORTH STAR MINES COMPANY, operating in the Grass Valley district, California, shows a net deficit of $102,690 for 1927. A total of 129,814 tons of material was mined and delivered to the sorting plant, of which 21,114 tons was discarded as waste, leaving 108,700 tons to be milled, with an average yield of $8.11 per ton. Per-ton costs were $6.95 for operation and $1.45 for development, a total of $8.40, and resulting in a loss of 29c. per ton. The yield per ton in 1927 was 25c. greater than in 1926 and costs were 61c. less. Option on the Plumbago mine, in Sierra County, Calif., was abandoned in June after the expenditure of $50,663, which was charged to profit-and-loss account.

Butte & Superior Earnings at Lower Rate in 1927

EARNINGS of the Butte & Superior Copper Company were $272,911 before depletion in 1927, a decrease from the $496,004 profit before depletion in 1926.

Comparative Statement of Operations

	1927	1926
Operating revenue		
Net value of zinc and copper ore	$2,670,697	$3,154,646
Operating costs		
Mining, development, and general expenses	2,360,802	2,558,067
Net income from operations	$309,894	$596,578
Other income	55,758	49,082
Total income	$365,652	$645,660
Charges against income		
Depreciation	$36,000	$72,000
Accrued taxes	56,741	77,656
	$92,741	$149,656
Net income for year (without deduction for depletion)	$272,911	$496,004

Tonnage mined in 1927 was 315,434 tons as compared with 394,495 tons in 1926.

General Manager Daveler discusses mine development work and present conditions as follows:

"The development program started in 1925 toward reclaiming remnants of zinc orebodies left behind in early operations on the upper levels was continued with satisfactory results, and a total of 158,196 tons was developed above the 1,300 level. Of this, 32,124 tons came from the abandoned ore estimated at the beginning of the year to be recoverable and the balance of 126,072 tons was ore not heretofore considered available. At the end of the year there remains in these old orebodies 112,641 tons, with an estimated assay of 7.17 oz. silver and 14.44 per cent zinc. It is believed that this tonnage will be increased by further exploration and these orebodies will be opened up for mining as they are required. Zinc development was continued on the deeper levels and resulted in the addition to reserves during the years of 85,572 tons below the 1,300 level. The total commercial tonnage of zinc ore developed during the year amounted to 243,768 tons.

"The decrease in the commercial zinc ore reserves from the beginning to the end of the year amounted to 152,608 tons, the decrease in tonnage being somewhat offset by an increase in the silver assay from 5.11 oz. at the beginning to 5.47 oz. at the end, and in the zinc assay from 14.89 per cent at the beginning, to 15.24 per cent at the end of the year.

"In the first part of the year development of the Rainbow Lode on the 3,400 and 3,600 levels was continued. A small tonnage of ore was opened up on the 3,400 level, and on the 3,600 level promising stringers were encountered over a broad zone of mineralization, with no bodies of commercial importance. To properly develop these lower levels it was found necessary to complete the No. 3 main hoisting shaft to a point 40 ft. below the 3,600 level, and this work was started in the third quarter and should be completed early in 1928.

"Copper development on the main copper vein was unsatisfactory and ore reserves were diminished 66,426 tons, of which 36,043 tons was abandoned as being too low in grade to mine, contrary to previous estimates. Production by mining from this copper vein will cease during the first half of 1928.

"The following is a comparison of the estimated ore reserves on both zinc and copper ores on Dec. 31, 1926, and Dec. 31, 1927:

	1927	1926
Zinc ore		
Commercial, tons	178,280	330,888
Average assay		
Zinc, per cent	15.24	14.89
Silver, ounces per ton	5.47	5.11
Copper ore, tons	4,214	70,640
Average assay		
Copper, per cent	3.36	3.80
Silver, oz. per ton	6.63	6.41

"Note: In addition to the aforementioned reserves, there are 115,000 tons of low-grade zinc ore, which, at present metal prices, it is unprofitable to mine.

"The foregoing statement of tonnages does not include the estimate of 112,641 tons of zinc ore in the old orebodies remaining at the end of the year. These cannot be developed sufficiently to permit accurate measurement except as they are mined."

Net Income of Hecla Mining Decreases Slightly in 1927

HECLA Mining Company, operating in the Coeur d'Alene district of Idaho, reports net income of $1,575,681 after taxes, depletion, depreciation, and all other charges. This is a decrease from the $1,874,535 earned in 1926. Dividend disbursements amounting to $1,000,000 were made in 1927, against $2,000,000 in 1926.

Income and Expenditures for Year Ended Dec. 31, 1927

Income		
Ore sales—net receipts	$3,672,113	
Interest	52,671	
Rents	51,474	
Miscellaneous	14,338	
		$3,790,598
Expenditures		
Mining and development	$1,077,357	
Crushing, conveying and ore sorting	44,366	
Ore haulage—mine to mill	30,881	
Milling	169,568	
Miscellaneous (general expense, insurance, property taxes)	324,626	1,646,801
Operating income		$2,143,797
Depreciation reserves	$253,942	
Depletion of property investment	11,665	265,608
		$1,878,189
Dividends	$1,000,000	
Taxes—federal income and state net profit and miscellaneous adjusting entries	302,497	1,302,497
Addition to surplus		$575,691
Surplus Dec. 31, 1926		3,196,933
Surplus Dec. 31, 1927		$3,772,624

Development work totaling 7,235 ft. was done during the year. Development work on the 2,400 and 2,800 levels was completed with the following results: On the 2,400 level the number of tons of ore per 100 ft. of depth was 156,833, against 92,032 tons on the 2,800 level. Ore reserves at the end of 1927 totaled 2,538,610 tons, sufficient for eight years at the present rate of production.

Crude Ore and Concentrates Shipped

	Dry Tons	Value	Per Ton
Concentrates	40,941	$2,467,331	$60.264
Crude ore	19,931	1,178,725	59.138
Leasers'	1,211	26,056	21.506
	62,085	$3,672,113	$59.146
Cost of production			$1,646,801
Total oz. silver produced			1,820,110
Total lb. lead produced			61,055,305

The record shows that 6.03 tons of milling ore produce one ton concentrate, and 5.00 tons of material treated produce one ton of shipping product.

Tonnage and Cost Statement for 1927

Tons milled	247,056
Tons crude	19,965
Tons leasers'	1,282
Tons waste	42,234
Total tons treated	310,537

Costs

			Per Ton Treated
Mining		$1,004,902	$3.236
Development		72,455	.233
Crushing, conveying and ore sorting		44,366	.143
Miscellaneous (general expenses, insurance, property taxes)		324,626	1.046
		$1,446,351	$4.658
			Per Ton Milled
Milling	$169,568		$0.686
Ore haulage	30,881		.125
		200,450	$0.811
Total operating expenses		$1,646,801	
			Per Ton Treated
Gross operating receipts		$3,790,598	$12.207
Gross operating expense		1,646,801	5.303
Net operating profit		$2,143,797	$6.904

KIRKLAND LAKE GOLD MINING COMPANY, LTD., reports net profit of $113,531 in 1927. During the year 52,648 tons of ore was milled, producing a gross bullion income of $473,673. Development work during the year consisted of 406 ft. of sinking, 667 ft. of crosscutting, 1,915 ft. of drifting, and 41,342 cu.ft. of station cutting. Per ton costs were as follows:

Development and exploration	$1.60
Mining and milling	3.98
Miscellaneous expense	1.28
Total	$6.84

A new 1,000-cu.ft. capacity air compressor was installed during the year to permit of more extensive development and exploration work.

BRITISH METAL CORPORATION, LTD., declared a dividend of 10 per cent on the ordinary shares, at the annual general meeting held in March. Trading profit for 1927 was £145,453, after deducing £50,000 for contingent reserve fund.

LAUTARO NITRATE COMPANY, LTD., of London, reports a net profit of £284,302 for 1927. Dividend No. 62, of 3 per cent, or 3s. per share, was paid on Jan. 23, 1928.

The Market Report

Prices of Copper and Lead Advance—Both Metals Active

New York, May 29, 1928—Buoyancy characterizes the markets for the three major metals in the non-ferrous group. Copper has sold in excellent volume, and now appears to be firmly established at 14¾c., Connecticut Valley. More than usual activity in lead is reported, and the New York price is now 6.30c. compared with 6.10c. a week ago. Buying of zinc has been almost non-existent, but some sellers are asking 6.15c., and there is no inclination on the part of producers to make concessions. Silver closes the week at 61⅞c., one cent lower than a week ago; tin is off a cent, and antimony and quicksilver each are a trifle easier. Metals in the platinum group are unchanged.

Daily Prices of Metals

May	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
24	14.275@14.40	51.50	6.10	5.975@6.00	6.10
25	14.50 @14.55	51.375	6.20	6.05@6.10	6.10@6.125
26	14.525	51.25	6.20	6.05	6.125
28	14.525@14.55	51.00	6.20	6.05	6.125
29	14.525	50.625	6.30	6.15	6.125
30	Holiday	.....	....	.....	.....
	14.490	51.150	6.200	6.063	6.118

Average prices for calendar week ending May 26, 1928, are: Copper, 14.379; Straits tin, 51.438; N. Y. lead, 6.133; St. Louis lead, 6.006; zinc, 6.115; and silver, 62.542.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

May	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
24	63¾	63⅞	67¾	230	229⅝	20 9/16	20 15/16	25¾	25½
25	64	64 1/16	68½	229¾	229¼	20⅞	21¼	25⅞	25⅝
28	Holiday	....	....	....	....	....	....	....	....
29	64 1/16	64 1/16	68½	227⅞	227½	21⅛	21½	25 15/16	25 11/16
30	63 15/16	63 15/16	68½	226⅞	226¼	21 7/16	21 11/16	26 1/16	25¾

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

May	Sterling Exchange "Checks"	Silver		Gold London	May	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
24	4.87¾	63⅝	28⅞	84s11d	28	4.87⅞	61⅝	Holiday	.....
25	4.87¾	62⅝	28 9/16	84s11d	29	4.87¾	61⅞	28¼	84s10½d
26	4.87⅞	61⅝	28 3/16	.....	30	Holiday	....	27¾	84s11d
			Avg.	62.275					

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Copper Advances Another ⅛c. to 14¾c.

For the sixth consecutive week copper has sold in excellent quantity. During three of these, including that ending today, the aggregate volume of sales in the domestic market has been phenomenal. At the same time a definite slowing up in demand has manifested itself yesterday and today. Last Thursday several large lots were sold in the morning at 14½c., but in the afternoon all sellers were at 14⅜c., at which price buying continued active. On Friday, with the exception of one large transaction for delivery several months ahead, all of a very large business was placed at 14¾c., Connecticut, and 14⅞c. in the Middle West. July shipment predominated, but August and June were represented, and an occasional order specified September, and on "spread" deliveries went even into October. The generally accepted explanation of the recent exceptional activity is that consumers who had run hand-to-mouth buying to the thinnest possible margin became frightened by the squeeze for prompt metal and the decline in stocks shown in the April statistics, and bought heavily to readjust their position. If this is so, a period of quietness is to be expected. However, the producers are generally well sold, and, encouraged by their recent success in out-waiting the buyers, are in an optimistic frame of mind. On Friday, May 25, the export price was advanced from 14¾c. to 15c. c.i.f. Buying at the higher level was good on Friday, but the holiday season which followed has prevented an opportunity to ascertain the attitude of foreign buyers since then.

Lead Prices Advanced Twice

The extremely favorable statistics of world lead production, and the sentimental effect of the advancing prices of copper, zinc, and silver, have had a most beneficent effect on the lead market both here and abroad. Consumers have been active buyers, and producers have made a general advance in their quotations twice; first, last Friday, May 25, when the American Smelting & Refining Company advanced its New York contract price from 6.10 to 6.20c., and second today, May 29, when another 10-point advance was made, to 6.30c., the highest price that has been registered since the middle of February. The first advance in the East did not bring a corresponding increase in the Middle West, where 6.05c., St. Louis, and 6.10c., Chicago, were realized by most sellers, with the exception of one good lot for early delivery, which brought 6.10c. on Friday. Today, however, after a good tonnage had been disposed of at the lower level, sellers in general went to 6.15c., St. Louis.

Foil and mixed-metal buyers proved exceptionally good customers, but the buying was well distributed among all classes with the exception of corroders, who are not usually particularly active in the market at this time of year. Most of the metal was for prompt or

June shipment, with a fair sprinkling of July orders.

No runaway market is expected, but the tone is distinctly firm and producers are well sold on their current production. Stocks were accumulated at somewhat higher levels, and it is unlikely that they will be liquidated for awhile.

Deadlock in Zinc

Extreme dullness has prevailed in the zinc market. Galvanizers, it seems, are engineering a buyers' strike, or something of that kind. Producers, on the other hand, finding themselves obliged to pay $40 for concentrate in Joplin, have come to the conclusion that they had better produce less slab zinc and sell it at a higher price. The situation is that either concentrate must come down or zinc must go up, and with miners having the production pretty well in hand, it seems likely that the latter alternative will prevail. Some second-hand lots are reported to have been sold at concessions from 6.125c., but producers are asking the full "eighth," or 6.15c.

Tin Fairly Active

Tin was in good demand until the last day or two, but the price has not been strong, gradually declining from the 51½c. level of last Thursday for prompt Straits. The premium on prompt, which was about ⅝c. last Thursday, has declined to about ⅜c., and promises soon to be still less. A fair business has been done in refined and 99 per cent grades at about ¼c. below prices for Straits.

Exchanges Steady

Closing cable quotations on the principal foreign exchanges on Tuesday, May 29, follow: Francs, 3.93⅛c.; lire, 5.27⅛ and marks, 23.94¾c. Canadian dollars, ⅜ per cent discount.

Note—The sterling exchange quotation, for May 11, "checks," was 4.87$^{9}/_{16}$, instead of the figure given in the May 19 issue, or the correction in the May 26 issue. It is hoped that this is final.

Silver Market Weaker

During the past week the silver market suffered a sharp decline, touching 61⅝c. on May 26 and 28, but has since shown some improvement, being quoted today at 61⅞c. The reversal of China's position and lack of interest shown by India have been the cause of the reaction. The closing tendency is uncertain.

Mexican Dollars (Old Mexican pesos): May 24th, 49⅜c.; 25th, 48½c; 26th and 28th, 47½c.; 29th, 47¾c.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, for all positions, 11c.

Cookson's "C" grade, spot, 15½c.

BISMUTH—Per lb., New York, in ton lots, $2.10. Smaller lots, $2.25 and up.

CADMIUM—Per lb., New York: 65c. @75c., according to quantity.

IRIDIUM — Per oz., $275@$300 for 98@99 per cent sponge and powder. Market dull, prices largely nominal.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $46@$49. Small lots bring up to $55. Absolutely no activity in market.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $78. Dealers and refiners quote the trade for refined metal, per oz., cash, for wholesale lots, $73.50@$74 bid, $75.50@$76.50 asked. Market very quiet.

QUICKSILVER — Per 76-lb. flask, $122@$123, depending on quantity. San Francisco wires, $125.

Prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of May 5.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn: 35@38c. Caucasian, washed, 53@55 per cent, 38@40c. Chemical grades unchanged from quotations in the May 5 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $11.00@$11.05. Western scheelite, $10.60@$10.75.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the May 5 issue.

Joplin Lead Ore Advanced

Joplin, Mo., May 26, 1928

Blende

	Per Ton
High	$42.35
Premium blende, basis 60 per cent zinc	$40.00@41.00
Prime Western, basis 60 per cent zinc	40.00
Fines and slimes, 60 per cent basis	36.00@39.00
Average settling price, all zinc	38.77

Galena

High	$80.80
Basis 80 per cent lead	80.00
Average settling price, all lead	78.76

Shipment for the week: Blende, 15,351; lead, 1,713 tons. Value, all ores the week, $729,590.

Shipment five months: Blende: 233,509; lead, 33,310 tons. Value, all ores five months, $11,438,020.

Zinc smelters were not anxious to buy heavily this week, nor were sellers disposed to increase sales, satisfied that prices will remain firm, with a possible upward tendency.

Platteville, Wis., May 26, 1928.

Zinc Blende	Per Ton
Blende, basis 60 per cent	$42.75

Lead Ore	
Lead, basis 80 per cent lead	$78.50

Shipments for the week: Blende, 690 tons; lead 80 tons. Shipments for the year: Blende, 15,353 tons; lead 920 tons. Shipments for the week to separating plants, 845 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the May 5 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. Market quiet.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the May 5 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105 quoted for last half, 1928. Spiegeleisen, 19@21 per cent, $32 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 95@98c. f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the May 5 issue.

Metal Products

ROLLED COPPER — Sheets advanced from 23¼ to 23½c. per lb. May 25; wire advanced from 16½ to 16⅝c. per lb., May 25.

NICKEL SILVER—Per lb., 18 per cent nickel Grade A sheets, price advanced from 29½ to 29¾c., May 25.

YELLOW (MUNTZ) METAL—Dimension sheets, 20¼c. from 20c. per lb.; rods, 17¼c. from 17c. per lb., May 25.

Lead Sheets, and Zinc Sheets are unchanged from prices in the May 5 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of May 5.

Iron, Steel, and Coke

Iron—Per gross ton, Valley furnaces, Bessemer, $17.50; basic, $16@$16.50; No. 2 foundry, $17.00@$17.25.

Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per pound, 1.85@1.90c.

Coke—Per gross ton, Connellsville furnace, contract, $2.75@$3; spot, $2.60@$2.75. Connellsville foundry, contract, $3.75@$4.25; spot, $3.50@$4.25. By-product coke, Ohio and Kentucky, $7; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ended May 26, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	73	68½	72¾	Ap.14, My.21 Q	0.75
Ariz. Com'l	Boston	5	4½	4½	Ja. 19, Ja. 31 SA	0.25
Cal. & Ariz	New York	107½	101½	106½	Jn. 8, Jn. 25 Q	1.50
Calumet & Hecla	Boston	24¼	23½	24¼	My. 31, Jn. 15 Q	0.50
Cerro de Pasco	New York	75½	69¼	74½	Ap.12, My.1 Q	1.00
Chile Copper	New York	44⅜	42¼	44	Jn.6, Jn.30 Q	0.62½
Con. Coppermines	N. Y. Curb	14	12½	13¼	.....	.....
Copper Range	Boston	22½	20½	22	Ma. 24, Ap. 20 A	1.00
Crystal Copper	Boston Curb	*70	*62	*67	.....	.....
East Butte	Boston	3	2⅞	3	Dec., 1919	0.50
Granby Consol	New York	56½	53½	55⅜	Ap.13, My.1 Q	1.00
Greene Cananea	New York	128½	118½	125⅜	Jn. 15, Ju. 2	1.00
Howe Sound	New York	62⅜	57⅞	62	Ma.31, Ap.16, Q	1.00
Inspiration Consol	New York	25½	22⅜	25⅜	Apr. 1927 Q	0.25
Isle Royale	Boston	22½	19	21	Fe.28, Ma.15 SA	0.50
Kennecott	New York	94¼	88⅜	94	Jn. 1, Ju. 2 Q	1.25
Magma Copper	New York	56½	53¼	55⅜	Ma.31, Ap.16 Q	0.75
Mason Valley	N. Y. Curb	1⅛	1⅛	1⅛	.....	.....
Miami Copper	New York	21⅞	20½	21⅞	My.1, My.15, Q	0.37½
Mohawk	Boston	62	58	62	Ap. 30, Jn. 1 Q	1.00
Montana-Idaho	Spokane	*30	*28	*28	.....	.....
Mother Lode Coal	New York	3⅜	3⅛	3⅛	Ju.8, Ju. 30	0.15
Nevada Consol	New York	25⅛	24	25¼	Ma.16, Ma.31 Q	0.375
New Cornelia	Boston	29½	28½	29¼	My. 4, My. 21 Q	0.50
Noranda	N. Y. Curb	27⅛	24⅛	26⅜	.....	.....
North Butte	Boston	2⅜	2	2	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*87	*80	*87	Sept., 1926	0.03
Old Dominion	Boston	15½	14	15⅛	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	135	132	135	Ma.20, Ap.2 Q	1.50
Quincy	Boston	40½	35½	39⅜	March, 1920	1.00
St. Mary's Min. Ld	Boston	33	30	33	Ap.1928 A	2.00
Seneca Copper	New York	4⅛	3½	4⅛	.....	.....
Shattuck-Denn	N. Y. Curb	20⅜	18½	19⅜	.....	.....
Tenn. C. & C	New York	15½	13½	15½	Ma.29, Ju.15,Q	0.12½
United Verde Ex	N. Y. Curb	23	21	23	Ap.6, My.1, Q	0.50
Utah Copper	New York	160	155	155	Ma.16, Ma.31 Q	1.50
Utah Metal & T	Boston	1⅜	1⅜	1⅜	Dec., 1917	0.30
Walker Mining	Salt Lake	1.07½	*87	1.07½	.....	.....
NICKEL-COPPER						
Internat. Nickel	New York	99½	86⅝	95⅜	Ma.15, Ma.31Q	0.50
Internat. Nickel pfd	New York	114½	114½	114½	Ap.12, My.1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*6	*5	*5	June, 1927	0.005
National Lead	New York	127½	126	127½	Jn.15, Jn.30 Q	1.25
National Lead, pfd. A	New York	147½	147½	147½	Ju.1, Ju.15 Q	1.75
National Lead, pfd. B	New York	....	....	120½	Jy. 20, Au. 1 Q	1.50
St. Joseph Lead	New York	48	44⅜	46	Jn.9, Jn.20, QX	0.75
ZINC						
Am. Z. L. & S	New York	31⅜	27½	29¼	May, 1917	1.00
Am. Z. L. & S. pfd	New York	90½	86	90	Nov., 1920	1.50
Butte C. & Z	New York	9⅜	6⅜	9⅜	De., 1926	0.50
Butte & Superior	New York	16⅜	13½	16½	Ma.14, Ma.31 Q	0.50
Callahan Zn-Ld	New York	4¼	3⅜	4	De., 1920	0.50
Consol.Lead&Zinc 'A'	St. Louis	16	15	15⅜	Ap., 1927	0.25
Eagle-Picher	Cincinnati	18⅜	17½	18⅜	No.15, De.1 Q	0.40
Eagle-Picher pfd	Cincinnati	102½	102¼	102¼	Ma. 31, Ap. 16 Q	1.50
New Jersey Zn	N. Y. Curb	225	220	221	Ap. 20, My. 10 Q	2.00
Treadwell-Yukon	Toronto	19.50	18.50	18.50	.....	.....
United Zinc	N. Y. Curb	*85	*73	*80	.....	.....
Yellow Pine	Los Angeles	*57½	*33	*33	Dec., 1925 Q	0.04
GOLD						
Alaska Juneau	New York	4	3⅜	3⅜	.....	.....
Ankerite	Toronto	*42½	*26	*40	.....	.....
Barry-Hollinger	Toronto	*97	*86	*88	.....	.....
Central Manitoba	Toronto	1.43	1.25	1.30	.....	.....
Cresson Consol. G	N. Y. Curb	1¼	1⅛	1⅛	Ma.31, Ap.10 Q	0.10
Dome Mines	New York	10	9½	9½	Ma.31, Ap.20 Q	0.25
Golden Cycle	Colo.Springs	†1.74	†1.72	....	My. 31, Jn.10 Q	0.04
Gold Hill	Toronto	*13	*11	*11½	.....	.....
Hollinger Consol	Toronto	15.70	15.10	15.40	My.30, Ju.16 FW	0.10
Homestake Mining	New York	71½	70½	71	My.19, My.25 M	0.50
Kirkland Lake	Toronto	1.90	1.77	1.87	.....	.....
Lake Shore	Toronto	24.10	23.65	23.75	Jn.1, Jn.15	0.20
McIntyre Porcupine	New York	....	....	26¼	May1, Ju.1 Q	0.25
Portland	Colo.Springs	†*18	†*13	...	Ap., 1927	0.02
Rand Mines	New York	....	....	43	Fe.21-28 Am.Sh.	1.52
Sylvanite	Toronto	3.15	3.05	3.05	.....	.....
Teck-Hughes	Toronto	10.55	9.95	10.02	Ja. 17, Fe. 1 X	0.15
Tom Reed	Los Angeles	*46	*43	*43	Dec., 1926	0.02
Tough-Oakes	Toronto	*31¼	*24½	*27	.....	.....
Vipond Cons	Toronto	*60	*58	*58½	April, 1927	0.03
Wright-Hargreaves	Toronto	4.56	4.25	4.30	Ap.13, My.1 Q	0.05
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	25⅜	21⅜	24¼	.....	.....
Con. Cortez	N. Y. Curb	*29	*28	*28	.....	.....
Dolores Esperanza	N. Y. Curb	1⅞	1⅛	1⅛	July, 1923	0.05
N.Y. Hond's Rosario	N. Y. Curb	16⅛	16⅛	16⅛	Ap.18, Ap.28 Q	0.50
Premier Gold	N. Y. Curb	2⅛	2⅛	2⅛	Ma.15, Ap.4	0.08
Tonopah Belmont	N. Y. Curb	....	....	1⅛	Oc., 1925	0.05
Tonopah Extension	N. Y. Curb	*17	*16	*17	Ap., 1925	0.05
Tonopah Mining	N. Y. Curb	4⅞	4⅛	4⅛	Mar.31, Ap.21 SA	0.07½
West End Consol	N. Y. Curb	*7	*5	*7	Mar., 1923	0.05
Yukon Gold	Boston Curb	*73	*66	*70	June, 1918	0.02
SILVER						
Beaver Consol	Toronto	1.44	1.31	1.38	May, 1920	0.03
Castle-Trethewey	Toronto	*75	*63	*73	.....	.....
Coniagas	Toronto	5.01	5.00	5.00	May, 1924	0.12½
Keeley	Toronto	*85	*65	*70½	Ma.1, Ma.15 SA	0.04
Lorrain Trout Lake	Toronto	...	...	*30	July, 1925	0.05
Mining Corp. Can	Toronto	3.60	3.40	3.55	My.20, Jn.13 SA	0.25
Nipissing	N. Y. Curb	4⅝	4⅜	4⅜	Ma.31, Ap.20Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	5	4½	4⅝	Ap., 1927	0.12½
Bingham Mines	Boston	50½	48	48	Ma.22, Ap.5 Q	1.00
Bunker Hill & Sullivan	N. Y. Curb	135	130½	130½	Ap.30, My.4 MX	0.75
Cardiff M. & M	Salt Lake	*81	*77	*81	Feb. 5, 1927	0.10
Chief Consol	Salt Lake	4.30	4.05	4.30	Ja.10, Fe.1 K	0.10
Consti'nMng.&Mill'g	Spokane	*15	*8¼	*12	.....	.....
Erupcion	Boston Curb	....	....	*30	Dec. 13, Jan. 3,	0.07½
Eureka Lily	Salt Lake	2.37½	2.05	2.37½	.....	.....
Federal M. & S	New York	....	....	130	Je., 1927	10.00
Federal M. & S. pfd	New York	99⅜	98½	98½	My.25, Jn.15 Q	1.75
Hecla Mining	N. Y. Curb	15	14⅜	14½	My.15, Jn.15 Q	0.15
Highland-Surprise	Spokane	*15	*12	*13	.....	.....
Iron King Mining	Salt Lake	*72	*65	*72	.....	.....
Keystone Mining	Salt Lake	†*.33	†*.25	...	Fe., 1926	0.07½
Lucky Jim	Spokane	*35	*34	*34	.....	.....
Lucky Tiger-Com	Kansas City	†7.95	†7.75	...	My.10,.My.19MX	0.07
Mammoth Mining	Salt Lake	1.62½	1.60	1.62½	De., 1926	0. 25
North Lily	Salt Lake	7.75	7.50	7.75	.....	.....
Park Utah	New York	14	12½	14	Ma.15, Ap.15 Q	0.20
Plutus Mining	Salt Lake	....	....	2.00	Ap.10, Ap. 16 Q	0.10
Silver King Coal	Salt Lake	12.50	12.00	12.25	Ma.20, Ap.2 Q	0.25
Silversmith	Spokane	*23½	*21½	*21½	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*63	*50	*60	.....	.....
Sunshine M. Co	Spokane	1.50	1.48	1.50	Fe.10, Fe.20	0.10
Tamarack-Custer	Spokane	*80	*75	*77	Sept., 1924	0.25
Tintic Standard	Salt Lake	13⅞	13½	13⅞	Ma.21, Ma.29Q	0.30
Utah-Apex	Boston	4½	4	4½	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	63½	60	62½	Jy., 1924	1.25
Cleveland-Cliffs Iron	Cleveland	120	116	119	Ap.13, Ap. 25. Q	1.00
Colorado Fuel & Iron	New York	77½	76½	76½	May, 1921	0.75
Gt. North'n Iron Ore	New York	22⅛	21¼	22	Ap. 9, Ap. 30 K	0.75
Inland Steel	New York	60½	57	57½	My. 15, Jn.1 Q	0.62½
Republic I. & S	New York	61	57½	60½	My.15, Jn.1 Q	1.00
Republic I. & S. pfd	New York	106½	106½	106½	Jn. 15, Jy. 2 Q	1.75
Sloss-Sheffield S. & I	New York	117½	117½	117½	Jn.9, Jn.20 Q	1.50
Sloss-Shef. S.&I. pfd	New York	115⅜	115⅜	115⅜	Jn. 20, Jn. 2 Q	1.75
U. S. Steel	New York	148	142½	146½	My.31, Jn.29 Q	1.75
U. S. Steel, pfd	New York	144½	142⅜	142⅜	Ap. 30, My. 29 Q	1.75
Virginia I. C. & C	New York	50	50	50	Jan., 1924	1.50
Virginia I.C.&C. pfd	New York	...	...	57	Jn. 16, Ju. 2 SA	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	...	...	27	Jy., 1927	1.45
So. Am. G. & P. New	N. Y. Curb	3¼	3¼	3¼	.....	.....
Alum. Co. of Amer	N. Y. Curb	174	160	172	.....	.....
Alum. Co. of Amer. pf.	N. Y. Curb	110	109½	109⅜	Ma. 15, Ap. 1 Q	1.50
Vanadium Corp	New York	87-	78	85¼	My. 1, My. 15 Q	0.75
Patino M. & E	New York	37⅞	33¾	37⅛	April, 1928	4s.
ASBESTOS						
Asbestos Corp	Montreal	35½	33½	35½	Jan., 1926	1.50
Asbestos Corp. pfd	Montreal	95½	94¾	94¾	Ma. 31, Ap. 16 Q	1.75
SULPHUR						
Freeport Texas	New York	72⅞	68½	71⅜	Ap.14,Ma.1QX	1.75
Texas Gulf	New York	73⅜	68¼	72¼	Ju.1, Ju.15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	48½	45	48¼	My.15, Jn.1	0.75
Amer. Metal, pfd. 6%	New York	115½	115	115	My.15, Jn.1	1.50
Amer. Met. pfd. 7%	New York	127	125	125	My.15, Jn.1	1.75
Amer. Sm. & Ref	New York	195⅜	188	193¾	Ap.13, My.1 Q	2.00
Amer. Sm. & Ref. pfd	New York	138⅜	138	138	My. 4, Jn. 1 Q	1.75
Consol. M. & S	Montreal	272	268	270	Ja. 16, SAX	6.25
Newmont Mining	N. Y. Curb	178	167½	178	Ma.31, Ap.16 Q	1.00
U. S. Sm. R. & M	New York	49½	46½	49⅜	Ap.5, Ap.14 Q	0.87½
U.S. Sm. R.&M. pfd	New York	54¼	53¼	54¼	Ap.5, Ap.14 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. A, Annual. SA, Semi-annually. M, Monthly. FW, four weeks. K, irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED May 8, 1928

Name	High	Low	Last	Date	Amount	Last Div.
Alaska Mexican ($5)	40/—	37/6	38/9			
Alaska Treadwell ($25)	147/6	144/6	145/—	Nov., 1926	4 (d)	
Aramayo Mines (25 frs.)	73/9	68/9	70/—	May, 1928	5 p.c. (†)	
Burma Corpn. (10 rupees)	14/6	13/4½	14/3	Jan., 1928	6 annas*	
Bwana M'Kubwa (5s)	4/10½	4/6	4/10½			
Camp Bird (2s)	5/—	4/6	4/10½	April, 1928	16¾ p.c.	
El Oro (£1)	4/10½	4/4½	4/9	Nov., 1924	2½ p.c.*	
Frontino & Bolivia (£1)	14/6	13/9	14/—	Jan., 1928	5 p.c.	
Mexican Corpn. (£1)	11/9	11/1½	11/6			
Mexico Mines of El Oro (£1)	47/6	40/—	47/6	Dec., 1926	3¾ p.c.*	
Mond Nickel	192/6	180/—	182/6	Feb., 1928	7½ p.c.	
N'Changa Copper Mining	9/6	9/—	9/3			
Oroville Dredging (£1)	4/3	4/—	4/3	Dec., 1923	3¾ p.c.	
Rhodesian Congo Border (£1)	20/10½	19/3	20/—			
St. John del Rey (£1)	11/4½	10/6	11/3	April, 1928	7½ p.c.	
San Francisco Mines (10s)	31/—	30/—	30/—	Jan., 1928	25s.	
Santa Gertrudis (£1)	16/—	15/3	15/9	Jan., 1928	7½ p.c.	
Selukwe (2s. 6d.)	12/9	11/4½	12/—	April, 1917	6¾ p.c.	
S. Amer. Copper (2s.)	3/3	2/10½	3/1½	Nov., 1917	75 p.c.	
Tanganyika (£1)	74/6	65/—	65/7½	Aug., 1927	7½ p.c.	
Union Miniere de Haut-Katanga (Brussels)	8,600	8,250	8,600	July, 1927	182.60 (‡)	

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation. §U. S. Dollars.